JAN 28 1889
LIBRARY

THE TELEGRAPHIC JOURNAL AND
ELECTRICAL REVIEW.

VOL. XXIV. JANUARY 18, 1889. No. 582.

CONTENTS:

PAGE
The National Defences 53
Fire Statistics and Fire Telegraph 56
Alkaline Accumulators (*illustrated*) 57
The Hermite Electro-Chemical Bleaching Process (*illustrated*) 58
The Submarine Boat *Gymnote* 59
D'Arsonval's Universal Aperiodic Galvanometer 60
Electric Lighting in Paris.... 61
New Wheel-Armature Dynamo Machine (*illustrated*)... ... 61
The Sprague Electric Road at Boston 62
The Lowth Telephone (*illustrated*) 63
Sir W. Thomson's Address... 64
Notes 65

PAGE
City Notes, &c. :—Western Counties and S. Wales Telephone Co. 70
The Eastern Telegraph Company 70
American Notes 71
The Western Counties and South Wales Telephone Company 72
Proceedings of Societies :—
The Institution of Electrical Engineers (*illustrated*) ... 72
New Patents 77
Abstracts of Published Specifications 78
Correspondence :—The Ries Electric Railway 78
Lighting by Vacuum Tubes 80
The Safety of Electric Lighting Installations 80
Lead Covered Cables 80

THE NATIONAL DEFENCES.

GENERAL satisfaction will be felt at the result of the interview of the deputation which waited upon the Prime Minister on the 4th inst. The terms of the address which that deputation submitted to Lord Salisbury for the consideration of the Government were of so clear, unmistakeable, and important a character that we think it well to reproduce them :—

"You are aware that in the summer of 1888 certain proposals were made by the Government to the inhabitants of five of the principal ports in the North for the defence of their coasts and commerce. Those proposals were made by Admiral Sir Vesey Hamilton, as representing the Lords of the Admiralty, and General Sir Lothian Nicholson, as the representative of the War Office; and the five ports selected were the Clyde, the Forth, the Mersey, the Tees, and the Tyne. The committees were formed at all the ports, who went thoroughly into the matter, with the result that they have all arrived at practical unanimity in their conclusions; and we, the undersigned, who have the honour of your lordship's attention this day, are representative men from each of the five committees in question. Our opinions have received the assent and support of the highly influential local press in the several localities, of all shades of political opinion. We therefore feel that we practically represent the interests of all classes in the North of England, and in Scotland, and probably of the whole country. The conclusions referred to are as follows :—(*a*) That the need for defence of our commerce and ports is urgent, and should be dealt with without delay. (*b*) That no proposals for defensive measures will be satisfactory unless they are effective and adequate. (*c*) That the five ports decline absolutely to accept any responsibility for the initiation, oganisation, or maintenance of that defence beyond expressing their readiness to do their best to provide the men required as volunteers, and to co-operate by placing at the disposal of the Government any local knowledge they possess. (*d*) That as it is of the essence of military science that the responsibility for adequate organisation for war must be centralised, and cannot be distributed without confusion and danger, and great loss of efficiency, they hold most strongly that the responsibility for the necessary measures must rest with the Government, and cannot be devolved, even in part, on the localities without disastrous results. They therefore consider it to be beyond their province to prescribe what is necessary and suitable for the defence of each particular locality, although fully alive to the danger in which they at present lie, and desirous to co-operate with the Government as already indicated. (*e*) They are strongly convinced that to reach a real solution of this great question the initiation of the necessary scheme of defence can only properly be put forth by the two departments of the Government concerned—viz., the War Office and the Admiralty; that the necessary organisation must equally proceed from and be maintained by those departments; and that the cost of it, including the payments, which may be unavoidable, to the volunteers, must be borne by the departments. (*f*) That with a deep sense of the danger to which our commerce and great mercantile ports are exposed through the present entirely inadequate nature of the defences, they call upon the Government and the departments concerned to lose no time in devising and promulgating a comprehensive scheme to guarantee the security of our ports, and restore that feeling of confidence which has lately been so seriously shaken, and which is the essential foundation of commercial enterprise and prosperity."

The deputation was composed of representatives of the Northern ports, and the views expressed in the address, and emphasised by Lord Armstrong, a member of the Defence Committee, naturally had special reference to the ports represented; but there can be little doubt that whatever steps may be taken with respect to the defence and protection of those parts will apply to other localities calling equally loud for consideration. Indeed, that such is the sense in which the representations made were received is acknowledged by Lord Salisbury, who in his remarks observed :—"The members of this deputation have come, or, at least they believe they have come, for a special purpose, but I noticed, as the speech of Lord Armstrong went on, that although he was speaking of particular commercial ports, he could not help seeing that a similar danger attached to all our coasts and to all our ports, whether large or small." . . . . "It is not only with respect to the ports, but of defences of all places on the coast, whether great or small, and the defences of all the approaches of our commerce generally."

The representations of the deputation have been received by Lord Salisbury in a broad and comprehensive manner. The responsibility of initiating that which has to be done, of devising what it shall be, and of carrying it out, is acknowledged and admitted by the Prime Minister to attach to the State. We have little doubt that the matter is already receiving that attention which, from its magnitude and importance it demands, at the hands of our War and Naval Departments. To the deputation and through them to the country at large, Lord Salisbury has pledged the Government to deal with the matter during the coming Parliamentary session. The manner in which it will be dealt with must necessarily be evolved by the departments accountable for the defences of the country, but to what extent the scheme, whatever it may be, will be carried out, and to what parts of the coast, will depend upon the liberality of Parliament. We heartily trust that the importance of the subject will be so apparent as to drown all party tactics and to create a universal desire to provide for what is necessary without stint. But one sentiment should animate us on an occasion such as this. Manifestly our mercantile ports and our coasts generally are perfectly open to friends or foes at the present time. Their defence rests entirely with our cruisers. Doubtless they would do their duty, but they cannot be in half a dozen places at one and the same time. What we have to do is to protect them and make them as safe as we can with all possible dispatch. Clearly all cannot be dealt with at once, but, as we have in a former article indicated, very much may be done in a very short time by the application of a judicious system of submarine mines. That this method of defence must come largely into operation is clear, and it is equally so that Lord Salisbury, when speaking of coast as well as port defences, alluded to the adoption of such a course.

It is to be sincerely hoped that the question will be brought forward early on the assembling of Parliament; that it will not be deferred till the army and navy estimates are considered; but that it will be taken up and dealt with as an independent measure. Little, if anything, can be done till the necessary means are provided by Parliament; and however well that which it is proposed shall be done is considered beforehand, the work involved in giving the scheme effect, will all have to be done afterwards. There is no reason to believe that any breach of those peaceful intercourses with other nations which we have so long enjoyed is to be feared; but as Lord Salisbury has himself pointed out "we cannot blind ourselves to the fact that there is a difference in the condition of affairs as it exists now with reference to the defence of our shores." It is but too true that railways, steam power, and many other branches of science have placed in the hands of foreign Governments a power capable of being directed in a very brief space of time upon us. Equally true is it that although at the present moment there is no reason to believe these powers are likely to be used against us for any aggressive purpose, "Ministries are not absolutely permanent," and no one can say into whose hands this great power may fall, or in what manner it may be used. Without mistrusting our friends and neighbours it behoves us to look after our own interests, and the sooner we can look around and see, and feel, that our coast defences, our harbours, and ports are provided with a reasonable and proper mode of defence the more secure we shall feel, and the more shall we be honoured as a nation prepared to defend her own.

THE projected electric underground railway from St. James's to Holborn Circus is by no means to be allowed to go on unopposed. As we stated last week a number of the ratepayers along the proposed route have held a meeting for organising resistance to the scheme on the avowed ground that such a railway would injure the property structurally and financially. The contention that the railway is not needed is of no value, for everyone knows that a line of this kind is very much wanted in the West Central District, and would be of great public advantage. The motive power contemplated being electricity, no objection on the ground of steam and unpleasant gaseous exhalations can be raised, therefore the Bill is to be opposed as dangerous. How much that reason is worth can be easily seen, for it is not worth much. Powers are provided for underpinning and otherwise treating buildings overhead so as to make them safe, and in view of what has been done in connection with the Metropolitan Railway, especially in the link that completed the Inner Circle, it is absurd to maintain that as good and safe work could not be carried out elsewhere. At all events very strong evidence to that effect will be necessary to defeat the scheme. The secret of the objection is to be found in another direction. Knowing what can be done to support buildings over subways the promoters do not propose to buy up the property along the route, but simply to bore underneath, underpinning where necessary, and, of course, compensating for damage to private property. Thereby the tradesmen and owners will lose the chance of obtaining fabulous sums such as railway companies frequently have to pay; and for this reason it is that the Bill is opposed.

WE notice that a contemporary last week in alluding to the City lighting makes the following remark, which is, perhaps, inspired; "We may add that the report furnished by Mr. Preece to Lieutenant-Colonel W. Haywood is of a confidential character." Surely this must be an erroneous statement, as the report in question was published in the REVIEW a week previously, having been specially sent to us for that purpose.

THE new law of New York—Death by Electricity—has been passed, and no provision has been made to carry it out. Apparatus is not provided, no competent specialists have been appointed to superintend its administration, and, in the present state of affairs, the present law appears to amount to little more than an indefinite suspension of the death penalty for murder.

THE *Scientific American*, in commenting on the new law, says:—"Every prison where the law is carried out must be supplied with the most perfect electrical plant. Every connection must be of the best, and all must be kept in perfect order. The effects of disuse, the hardest of all deteriorating causes to combat in their influence upon machinery, must be guarded against. All this apparatus may stand idle from year to year, only to be used on the rare occasions of an execution. To apply and run the apparatus and to inspect every detail a skilled electrician will be required. The voltage must be accurately determined, the number of alternations of current per second must be known, if the alternating current is to be used, and the resistance of the person to be killed should be determined. There should be no chance of a failure, and all must be definite and known. It remains to be seen whether a competent person will undertake a duty to which some measure of odium will inevitably attach. The successor of the present hangman can be depended on to make the fatal contact, but that is all. The electrodes must be attached to the person by or directly under the superintendence of the electrician. The struggles of the prisoner, by disturbing the position of the electrodes, may bring about the most deplorable results. As it is now, far too many executions by hanging fail in the end of quickly killing with little suffering. But where the vastly more complicated mechanism of an electric plant is depended on, the possibilities of a failure are largely multiplied." All the objections here advanced would occur to most people who had seriously studied the subject, but as we remarked in our issue for the New Year, we see no insuperable difficulties in the way of its adoption. An electric plant for such a purpose need be in no way complicated, and might be regularly employed for other work, so that the plea of standing idle and deteriorating would fall to the ground. Indedependently of this we have sufficient confidence in the skill of American experts to believe that the new law can be carried into effect without the least chance of the deplorable results which the *Scientific American* seems to anticipate.

IT has, of course, long been the desire of many inventors to produce a telephone which should not trench upon the ground covered by Prof. Bell, and many ingenious instruments have been the result of these trials of skill in evading a patent. Next week we hope to illustrate an apparatus which is believed by the inventor to be without the claims of the United Telephone Company, but as the transmitter appears to be the *bête noir* of all attempts to start rival telephonic enterprises we cannot see that much is to be gained by spending time upon the production of a new receiver, especially as these are now made in several forms without infringing the Bell patents. As a matter of scientific interest, however, our readers may like to see the apparatus in question.

AN opportune protest by Sir William MacCormac appears in the *Lancet* of last week. He remarks that in the *Telegraph* of January 8th appeared a whole-page advertisement of the "Electropathic Belt Company and Zander Institute," and a column was chiefly devoted to announcing the medical patronage they had received. The company, Sir William says, has taken an unwarrantable liberty in advertising his name as one of its supporters. The remainder of the "protest" we give in Sir William's own words:—"The Zander Institute was once respectable, and I recently advised a patient to go there, not knowing it had changed hands. Had I known into whose hands it had passed I should have carefully avoided it."

MR. GEORGE CRIGHTON, writing to the *Daily News*, describes an incident of which he was a witness in the City a few days ago. Two overhead wires crossing Old Broad Street, oscillated by the wind, came into frequent contact, a brilliant star-like light resulting. What this means there is no need to tell our readers, but we may warn those concerned to look after their lines before some catastrophe occurs in consequence of this conjunction of electric light and telephone or telegraph wires.

THE councillors of Leamington, tired of the inefficiency of the electric lighting of their streets, have at last given Messrs. Chamberlain and Hookham twelve months' notice to terminate their contract. This result was not unexpected. We cannot help commiserating somewhat with Messrs. Chamberlain and Hookham, but are bound to confess that they have themselves chiefly to blame. Once more we repeat that the idea of street illumination by means of incandescent lamps is a fallacious and mistaken one. That was the system with which the contractors commenced: latterly, however, they have introduced arc lamps—but arc lamps which would not burn consistently, lamps which fizzed and spluttered and popped out every now and then. Surely there is a sufficient number of really good arc lamps in the kingdom to make it unnecessary for the contractors at Leamington to employ lamps of so unsatisfactory a character. Lamps which may be depended upon to burn steadily and keep alight are well known, no doubt even to Messrs. Chamberlain and Hookham, and there is no need for us to repeat the names of them. It is a great pity that electric lighting interests should be so greatly damaged by these half-and-half attempts to carry out important undertakings. The Leamington Council thinks that their contractors not only gave them a worse light than that formerly derived from gas, but were exceedingly immoderate in the estimates they rendered for improved lighting. We trust this *fiasco* at Leamington will be a warning to electricians everywhere. The moral is obvious.

THE second report of the New York Board of Electrical Control has just reached us, and it is full of valuable information. We shall hope to review the contents at some length in a succeeding issue, but it may be interesting to note here that although there are 4,500 miles of underground conductors in the City of New York, and, notwithstanding the removal of a considerable number of poles during the past year, there are to-day more overhead wires in that city than existed a year ago. *Apropos* of the little accident which happened a few weeks ago in London through the crossing of telephone and lighting wires, it has been decided in New York not to allow telegraph and telephone wires to be placed on the same side of the street as electric light conductors.

FIRE STATISTICS AND FIRE TELEGRAPH.

By R. VON FISCHER-TREUENFELD.

CAPTAIN EYRE M. SHAW, C.B., the indefatigable and gallant chief officer of the Metropolitan Fire Brigade, has not been slow in bringing forward his annual report on the London fires of 1888. According to information contained in the *Daily Telegraph* of the 5th of January, this report was, with the characteristic and renowned celerity of the London Fire Brigade, already presented to the Metropolitan Board of Works on the 4th inst.

The official returns compiled by Captain Shaw in that report are a self-speaking proof of the enormous work which had to be done. If we consider that 4,228 calls, or just 12 a day, had to be attended by firemen with suitable appliances, and that the number of firemen available for general work at fires and employed on the several watches kept up throughout the Metropolis, consists only of 591 men, including officers and superintendents, we forcibly come to the conclusion that the amount of work accomplished was very heavy during the past year.

We shall presently see from the figures in the following table, that the Metropolitan Fire Brigade has not only performed its work most gallantly, but Captain Shaw's latest report adds a welcome new leaf to so many previous ones, which all record a steady and undeniable progress in conquering a common and never ceasing enemy, an achievement which not only merits the high approval of the Metropolitan Board of Works, but of every inhabitant of this vast Metropolis.

As we are here principally concerned with that part of Captain Shaw's report which relates to fire telegraphy, and with the influence which this has upon the protection of life and property, we shall only consider those figures of the report which bear upon these questions.

Year.	Number of fires (false alarms and chimney fires not included).	Number of points at which fire alarms can be raised.		Proportion between public alarm points and inhabitants.	Percentage of serious fires (all according to Capt. Shaw's own classification).	Lives lost per 100 fires, not including lives of men belonging to the brigade.
		Electrical street call points only.	Total number of alarm points, including engine and fire escape stations, street call points, telephone, telegraph and bell alarm stations.			
1878	1659	...	163	1 : 18,857	10	1·51
1879	1718	...	170	1 : 18,871	9	1·86
1880	1871	40	218	1 : 15,333	9	1·76
1881	1991	44	233	1 : 14,923	8	2·01
1882	1926	77	271	1 : 13,322	9	1·87
1883	2144	151	407	1 : 9,203	9	1·82
1884	2289	220	470	1 : 8,256	9	1·83
1885	2270	263	510	1 : 7,871	7	2·07
1886	2149	347	603	1 : 6,880	7	2·28
1887	2363	349	642	1 : 6,565	7	2·33
1888	1988	358	656	1 : 6,529	6	2·41

Leaving aside all calls for chimney fires and false alarms, there were 1,988 actual fires, of which 121 resulted in serious and 1867 in slight damage, or in other words, there were six per cent. of serious fires. This percentage of serious fires when compared with that of the last ten years, shows the highly satisfactory result that the Metropolitan Fire Brigade has gradually but steadily reduced the percentage of serious fires from ten to six, which means that the percentage loss of property has also decreased every year.

In a paper read in February, 1877, before the Society of Telegraph Engineers, I distinctly pointed out that the percentage of London serious fires would become considerably reduced with an increase of those points at which fire alarms can be raised. I then dwelt upon the truth of my statements that in towns with a perfect system of rapid fire alarm communication, say one public alarm point to every 2,000 or 4,000 inhabitants, as is the case in Cologne, Hamburg, Berlin, Amsterdam, Stockholm, Vienna, &c., the serious fires can be reduced to an average percentage of four, or even less.

It is highly satisfactory to see that the progress stated in the fire statistics of the annual reports of the chief officer has been in strict accordance with the anticipations of twelve years ago. In the year 1878, London had only one public alarm point to about every 18,800 inhabitants, with the result of 10 per cent. of serious fires; whereas in the year 1888, the number of alarm points having been gradually increased, principally through the introduction of electrical street calls, London possessed one public alarm point to about every 6,500 inhabitants, with the more satisfactory result of 6 per cent. of serious fires. It would, therefore, only be a logical conclusion to say that, as soon as the number of the London fire alarm points shall have reached its practical maximum of about one to every 2,000 inhabitants, the percentage of serious fires will then also have reached its anticipated minimum of about 4 per cent.

The total number of alarm points which London possessed during the past year was 656, arranged in the following manner:—

55 Land fire-engine stations.
4 Floating or river stations.
27 Hose-cart stations.
127 fire-escape stations.
358 electrical street call-points round fire stations, and included in 55 alarm circuits.
21 telephones to police stations.
12 telegraphs
35 telephones } to public and other buildings.
17 bell alarms
—
656 public fire alarm points.

With reference to the death-roll caused by the yearly London fires we find in Captain Shaw's report that life has been imperilled during the past year in 123 fires, and that the number of persons seriously endangered by fire has been 178, of whom 130 were saved and 48 lost their lives; or, in other words, the lives lost at every 100 fires amounted to 2·41.

It is a deplorable fact, which I already proved in another paper, read in March, 1888, before the Society of Telegraph Engineers and Electricians, that the percentage of lives lost through fires has hitherto not been appreciably influenced by an increase of alarm points. In spite of the increased efficiency of the brigade and of more extended telegraphs and other alarm points, modern fires show a more destructive tendency, so that an increase in the percentage of lives lost is steadily apparent.

This deplorable fact should, however, never dishearten our hopes that the fire brigade will finally reach an efficiency, when it not only will be in a position to prevent a more rapid increase in the death-roll from fires, but when it will actually diminish that rate to an unavoidable minimum. The figures relating to the percentage of serious fires and to the protection of property lead us to the conclusion that the appliances available to the brigade and the number of men composing the force are not in proportion to the responsibility and to the amount of work which rests upon the London Fire Brigade, and that an increase of men, fire stations, and electrical communications would undoubtedly further reduce the serious damages to London property. Only with such an increase of resources a decrease in the proportion of lives lost may become realised.

Every one who has observed the renowned bravery and deeply-rooted sense of duty of the corps of the London Fire Brigade, and the amount of hardship with which that far too small force accomplishes its honourable duties, must maintain the earnest desire to see Captain Shaw's hands strengthened by a considerable increase in force and appliances, and the reluctant ratepayer would then soon find in the future reports of the chief officer of the Metropolitan Fire Brigade that his property and life had become more and more secure.

ALKALINE ACCUMULATORS.

By P. B. E.

To invent a reversible couple, or secondary battery, with iron, copper, or carbon plates in an alkaline solution has been the aim of many electro-chemists ever since Planté gave to the world, in his modest, unostentatious way, the first so-called accumulator. The advantage of a light and strong metal for the plates, a solution nearly neutral when in a state of discharge, for transport at ordinary rates, and non-injurious to adjacent metal work, no fumes of any kind and the use of a sheet iron cell or tin box being alone of sufficient attraction without considering the possibility of attaining a higher rate of discharge without injury and a greater amount of energy stored per pound of cell.

But although many attempts have been made, nothing of any practical value appears to have been reached until in 1886, a French engineer, Monsieur Desmazures, who, together with his chemist and electrician, Monsieur Commelin, and his associates, Messieurs de Virloy and Bailhache, had been trying all possible combinations with more or less—but never any complete—success, mainly for want of a negative plate that would freely absorb the oxygen of the charge and give it back in the discharge, bethought himself of first obtaining *a perfectly non-coherent mass of pure metallic copper* by electrical reduction from the oxide, and then compressing it in a steel mould to the extent of some thousand atmospheres by means of a hydraulic press.

On immediately carrying out this idea they found that, by nothing but an enormous pressure, it was easy to make a pure copper plate of equal strength and hardness to rolled copper from the loose reduced metallic "mud."

Then by regulating the pressure so as to produce an *apparently* solid copper plate, but, in reality, of only about two-thirds the specific gravity of rolled copper and consequently *infinitely porous*, a beautiful negative plate was produced. I use the term "beautiful" in a literal sense, for every one who sees these plates with their planished surface of shining copper cannot but admire them. This plate was found to possess the properties required—perfect depolarisation and very low electrical resistance.

It was then only a question of finding a suitable solution from which a metal could be alternately deposited upon the positive plate and re-dissolved.

Research having already been made in this respect, it was an easy matter to test the most favourable results in combination with the new negative plate, and the following general construction has been finally adopted with certain modifications when used for special purposes:—

A copper negative 2 to 3 mm. thick, enclosed in an envelope of parchment cloth (ordinary parchment paper being liable to get torn by rough handling), opposed to an iron positive plate of wire gauze, in a solution of zincate of potassium of 50° Beaumé, the whole contained in a thin sheet steel tinned box. An extremely strong, light, and serviceable cell is thus obtained. During the charge, the zinc in the solution is deposited upon the iron gauze plate, and the superfluous oxygen is absorbed freely by the copper plate. In the discharge, the zinc is redissolved, combining again with the oxygen from the copper plate.

It will be thus seen that there is no reason why the plates should in any way suffer, and it is found, after the considerable experience referred to hereafter, that, whilst the iron plates remain absolutely unchanged, the copper plates actually become harder and stronger by long use.

These cells give a comparatively low E.M.F., and a very large quantity of current, and where small quantity only is required the cells may be made up in cases of three, one of such boxes measuring 10 inches by 4½ inches by 10 inches (high), and weighing 28 lbs., giving a discharge of 150 ampère hours, at from 2·70 to 2·05 volts, according as the rate of discharge be slow or rapid. This division into three cells for each box is very favourable in preventing swilling where much knocked about.

A discharge may be made in as little as 2½ hours with fair efficiency and perfect safety to the plates, and for sudden efforts, such as are required for tramway work, a current of 200 ampères may be obtained without injury from a cell weighing 19 lbs. This was actually shown by Messieurs Sautter, Lemonnier, of Paris, when they kindly lent a battery of these cells to the Academie des Sciences for illustrating the Cowles aluminium process. The cell may be completely sealed up for portable work, and, when used for stationary purposes, the solution may be covered by a film of oil to prevent carbonisation and creeping up the terminals.

The notice of the French Government experts was early drawn to this invention, and in the spring of 1887 a battery of 132 cells, weighing 40 lbs., each was ordered for a large steel launch.

This launch was thoroughly tested at Havre, the following months of September and October, with the result that the naval authorities ordered a large battery of 560 of the same cells (9¾ tons) for the new submarine torpedo boat, the *Gymnote* then being designed by Monsieur Zédé and Captain Krebs. Meanwhile a few tests were carried out in London where an electric omnibus was driven by 14 cwts. of these cells at the same speed as 28 cwts. of the most approved lead cells could drive it.

This battery was tested at Havre by the Government officials previously to its installation on board the *Gymnote* and accepted as most satisfactory.

An account of these tests was read by Monsieur Mascart before the Academie des Sciences, at Paris, and showed a total weight of 37 *kilogrammes* per electrical horse-power hour, and an efficiency of 65 *per cent.*, without including a considerable residual charge afterwards taken from the cells.

The *Gymnote* was not launched until last autumn, and the trials did not take place until a few weeks ago. It is described in *La Nature* (December 22nd, 1888) and *L'Illustration* (December 8th, 1888) from which a few short extracts are translated as follows:—

"A first attempt, in November, 1876 (? 1886), with Monsieur Reynier's accumulators installed in a torpedo launch failed completely. Without being discouraged, Messieurs. Zédé and Krebs applied to Messieurs Commelin, Bailhache and Desmazures, who had just invented the light alkaline accumulator, and, on September 20th, 1887, the same boat in which Monsieur Reynier had failed underwent the triumphant trials at Havre which resulted in the acquisition of the electric torpedo launch by our navy.

"Without loss of time the engineers set to work, certain of success. Captain Krebs built his multipolar motor of 60 H.P. Monsieur Zédé entrusted Monsieur Romazoff, naval constructive engineer, with his plan of the *Gymnote*, which was laid down in the Toulon Arsenal, and Monsieurs Commelin and Desmazures proceeded with the construction of the giant battery of 564 accumulators to have a capacity of 93 millions kilogrammetres (345 H.P. hours).

"The much regretted Monsieur Desmazures died very suddenly last January, but Monsieur Commelin, assisted in a patriotic manner by Madame Desmazures, was well able to finish his part of the work.

"The *Gymnote* is propelled by a powerful 4-blade screw 1 m. 50 in diameter. The motor is Captain Krebs's invention. It has 16 poles arranged round a ring armature one metre in diameter, furnished with a commutator and four brushes—two for going ahead and two astern.

"The speed is 200 revolutions per minute, and the propeller is driven directly. The motor weighs 2,000 kilogrammes, and gives 60 H.P., with the normal current of 220 ampères at 220 volts.

"The electrical energy is provided by the battery of 564 alkaline accumulators completed by Monsieur Commelin. Each cell weighs 17·5 kilogrammes, making a total weight of 9,840 kilogrammes.

"Taking the total capacity of 345 H.P. hours, the weight per H.P. hour stored is 28·6 kilogrammes. This allows for a speed of 10 knots for 6 hours.

"The trials at Toulon were begun in the Vauban Dock, and continued in the open sea. They surprised beyond measure the few privileged spectators. The boat manœuvred like a fish, on the surface as well as below, and maintained the desired depth with precision at all speeds, changing direction and taking up the position ordered with great facility."

We cannot speak too highly of the complete success which has crowned the efforts of Messieurs. Zédé, Krebs, Commelin and Romazoff, who may be proud of their work.

But the most favourable and important field for the use of these cells—where the very shaking to which they would be subjected would be most advantageous—is the traction of tramcars and vehicles of all kinds running on paved roads. For this purpose the lightness, strength, and durability under great varieties of discharge, coupled with absence of fumes to corrode machinery, are a very great consideration, and steps have already been taken with a view to using the accumulators on the Paris tramways, where something will probably be done in time for the opening of the exhibition.

Diagram of two Dischargers.

Cell measuring 6″ × 3½ × 6″ outside
Weight of box and solution ... ... 6 lbs.
Total weights of plates, copper and iron 3 „
Total weight of cell ... ... 9 „
Charge 10 ampères for 12 hours at 1 volt (average E.M.F.)
Solution zincate of soda 45° Beaumé.

The dotted lines give an idea of the improvement caused by agitation of the solution during the discharge.

Discharge through a constant resistance of ·0017 and ·0066 ohms respectively.

These figures are to be considered approximate only, the measuring instruments not being so delicate as could be desired; but, as one of the first experts of the day is about taking exact tests, such data will soon be available.

The above diagram shows two idiosyncratic curves of discharge, one at a very high rate and the other at a normal rate.

The peculiar rise in E.M.F., especially remarkable in the case of the heavy discharge, may be accounted for partly by the decrease in internal resistance, caused by the solution rising in conductivity as it increases in density, and partly by the rise in temperature having a similar effect, much more noticeable in the curve of rapid discharge.

The great question of a perfect miner's lamp has occupied the attention of those connected with this new accumulator, and by substituting a thin plate of *silver*, made by the same process, for the copper plate, an increase of about 100 per cent. is obtained in E.M.F. Consequently the "silver cell" only weighs about *half* the copper one for a given output.

For a miner's lamp, the battery with silver negative plates only weighs 3 lbs. for 50 watt-hours, and of this weight not more than ½ lb. would be silver—always preserved in its metallic form, with no waste or deterioration in value—the cost of which is 32 shillings; but as the process of manufacture actually raises the value of the metal by purification (it is the same in the case of copper, and a point of great importance), this outlay in silver is not a costly matter, 4 per cent. per annum covering wear and tear, depreciation and interest.

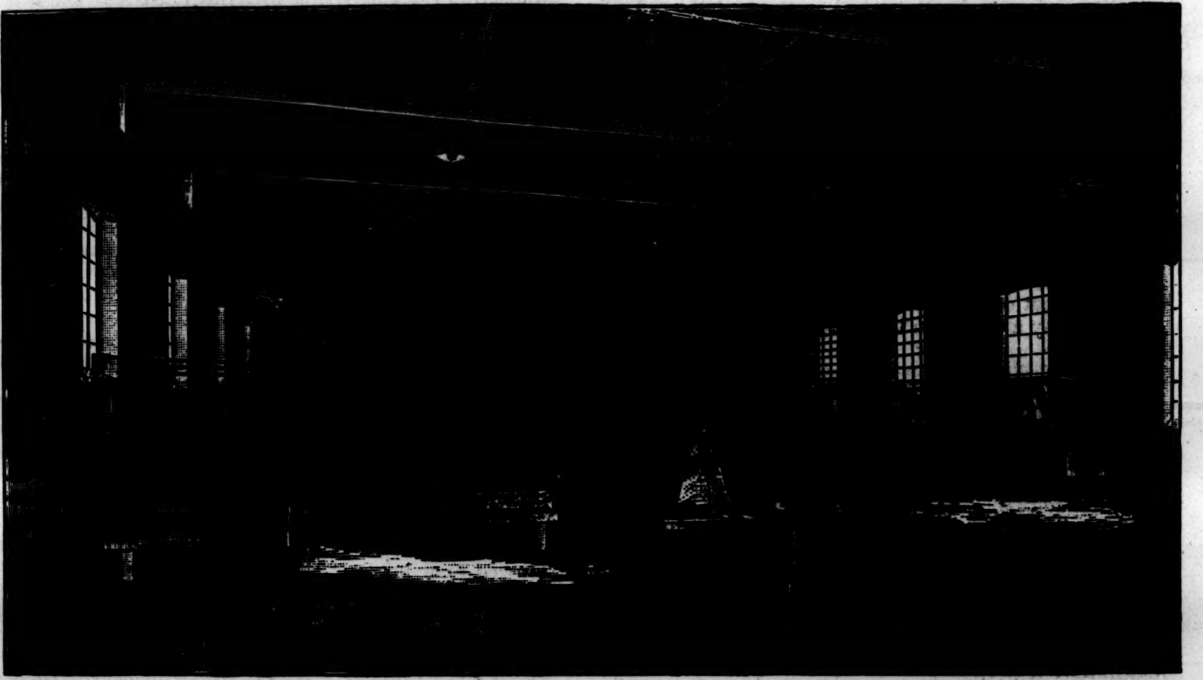
THE HERMITE ELECTRO-CHEMICAL BLEACHING PROCESS.

THE above illustration represents the arrangement of machinery lately installed at Messrs. Evan & Owen's paper works, near Cardiff. The plant is capable of producing equal bleaching effect to two tons of bleaching powder per 24 hours, and was constructed and installed by Messrs. Paterson & Cooper to the order of the Hermite British Electro-Bleaching Company, Limited. We have already described the Hermite process, and we only need say briefly that it consists in manufacturing a solution of high bleaching power by electrolysing an aqueous solution of magnesium chloride. The salt is decomposed by the current at the same time as the water. The nascent chlorine, liberated from the magnesium chloride, and the nascent oxygen, liberated from the water, unite at the positive pole, and produce an unstable oxygen compound of chlorine of very high bleaching power. The hydrogen and the magnesium go to the negative pole; this last decomposes the water and forms magnesium oxide, whilst the hydrogen is disengaged. If in this liquid coloured vegetable fibre is introduced, the oxygen compound acts on the colouring matter, oxydising it. Chlorine combines with the hydrogen to form hydrochloric acid, which finding itself in the presence of magnesium in the liquid combines with it and forms the initial chloride of magnesium. Thus a complete cycle of changes goes on so long as the electric current acts on the solution in the presence of colouring matter. The cycle is a perfect one, in which there are four elements: the electric current, chloride of magnesium, water, and the colouring matter. Only two of these elements are used up whilst bleaching: the electric current and the water. The magnesium chloride serves over and over again. There is only a simple displacement of molecules, and the chlorine acts as a vehicle to discharge the nascent oxygen on the colouring matter. Mr. Eugene Hermite, the inventor of the process, has found, after prolonged research, that it is magnesium chloride which of all chlorides gives the only commercial and complete results.

The plant at Messrs. Evans & Owen's Works consists of 20 electrolysers arranged in two rows, through which the solution of magnesium chloride is constantly circulated. Each electrolyser consists of a galvanised iron box open at the top, and with a perforated pipe at the bottom. The box is filled with the electrodes, which consist of a series of platinum plates connected to the positive pole of the dynamo, and a series of circular zinc plates interspaced with the platinums and connected to the negative pole of the dynamo. The solution is admitted at the bottom through the perforated pipe, passing in between the plates, and, being decomposed, overflowing the sides of the box, then falling into a cement tank underneath. From this bottom tank it is taken by means of a 12-inch centrifugal pump into the tank above, and is ready to pass through the electrolyser again according to the strength required. The top tank is a large, egg-ended boiler, and is connected to each electrolyser by means of a rubber pipe and cock. It is from the bottom tank that the solution is pumped over to the bleaching mill, a distance of some 50 yards, by means of an 8-inch centrifugal pump, where it is received in tanks from which it is drawn as required. The method of working is very simple; the pulp ready to be bleached being in a potcher, the electrolysed bleaching solution is run in, and the washing drum kept working. As the solution passes through the pulp its bleaching power is exhausted, and it is returned by means of a pipe to the top tank from which it originally started, and from whence it again passes through the electrolyser and is regenerated. The amount of solution remaining in the pulp after bleaching is recovered by a system of displacement in drainers, or by means of a press pâte.

The current is supplied by three of Paterson & Cooper's Phœnix shunt-wound dynamos, each giving a current of 1,000 to 1,200 amperes, with a difference of potential at the terminals of 40 volts. The electrolysers are arranged in series, eight on each of two dynamos and four on the other. This has been so arranged that another four may be added when required. Each circuit has an ammeter and voltmeter connected. The dynamos are driven by a compound condensing engine of the tandem type, capable of indicating 300 H.P., the amount actually taken up at present being 200 H.P.

An important part of the plant is that for the preparation of the magnesia necessary for keeping the solution basic. It consists of a vertical tank fitted with a stirrer, in which lime milk is made. This is run from thence into a shoot, discharging into any one of three vertical tanks, each fitted with a stirrer. These tanks are all placed above the main tank supplying the electrolysers, so that by merely opening a cock the "base," when prepared, can be run down at will. The three vertical tanks are partly filled with a solution of magnesium chloride, and then filled to the top with the lime milk. The lime throws down the magnesia, the calcium chloride which remains is syphoned off, the magnesia being then washed twice is ready for use.



The cost of bleaching by this system is said to compare very favourably with the old process. The fibres bleached are not deteriorated in strength to anything like the same extent as with bleaching powder. There are many modifications of the process for the bleaching of linen and cotton yarns, piece goods, &c., and also many different forms of apparatus, which are the subject of numerous patents in the names of Messrs. Hermite, Paterson and Cooper, in England and abroad.

The plant has been manufactured and erected by Messrs. Paterson and Cooper, electrical engineers, London, under the personal superintendence of Mr. Hermite.

This process has been adopted by several paper makers, on a large scale by the following :—

Messrs. Darblay Pere et Fils, Essonne, France.

Messrs. C. de Montgolfier et Cie, La Haye Descartes, France, where it may be seen at work.

Messrs. S. D. Warren & Co., Boston, U.S.A.

Messrs. W. A. Russell & Co., Boston, U.S.A., and others.

The three first have increased their plant after a lengthened trial in a portion of their mills.

THE SUBMARINE BOAT "GYMNOTE."

AT the meeting of the Académie des Sciences, on December 17th, Admiral Paris presented a note on M. Zédé's submarine boat, the *Gymnote*, in which he said :—In April, 1886, I had occasion to present to the Academy a note in which M. Zédé set forth the realisation of the idea of his illustrious master, Dupuy de Lôme, for the creation of submarine boats with electric motors. Towards the end of the same year M. Aube, then First Lord of the Admiralty, asked M. Zédé to carry this idea into practice, and, at his orders, a boat called *Le Gymnote* was constructed at the arsenal at Toulon. It has just been tried, and, according to the newspaper reports, has met with unhoped-for success.

The dimensions and internal construction of this boat are to all intents the same as indicated in the above-mentioned note; but, as it is used for military purposes the Academy will excuse me from entering too fully into details. I will merely say that the *Gymnote* is propelled and steered, both on the surface of the water and underneath, with perfect ease; that it maintains itself at the depth chosen with rigorous exactness, that the speed is as great as could be expected, that respiration is unimpeded, and sight perfect to a certain depth, and the course ensured at any level. M. Zédé has great pleasure in stating that Captain Kreb's electric motors are marvels of lightness and accuracy, and that this important part of the construction has been carried out by a master hand. The available power stored up is 240 H.P. hours. Lastly, such complete success at the first trial would have been difficult without the scientific knowledge, ingenuity and careful attention to details bestowed on the construction by M. Romazoff, naval engineer of the port of Toulon. M. Zédé wishes the important part played by his *collaborateurs* to be fully appreciated.

Thus a solution has been found to the problem of the submarine boat; this is only a first attempt, better will be done. But, as it is, the *Gymnote* can render certain services.

It it is for the Admiralty to judge what use can be made of it as an engine of warfare; but, besides this application, there is another which concerns the Academy; this is the use to which such a boat might be put for submarine explorations.

By constructing a hull of sufficient strength to resist the pressure at considerable depths, and reducing the speed to what would be suitable for such a purpose, the bottom of the sea might be minutely explored, the position being changed at will, and sight-holes being made at suitable places, and a system of electric lighting included in the arrangements. By this means we might surprise many of the secrets of the inhabitants of these depths. By means of special instruments issuing from watertight cases interesting specimens might be seized and brought on board. Lastly, by remaining in communication with the telephone, the dredging and sounding instruments might be guided. All this can now be practically carried out. I may observe that when discussing the question of submarine boats we must not omit to mention that Admiral Bourgeois, then a ship's captain, seconded by M. Brun, naval engineer, took a submarine trip in 1858 with his boat the *Plongeur*, steering with the ordinary rudder, and maintaining the level with two horizontal rudders. But as electric motors were then unknown, compressed air was employed, which, besides imparting the motion, was of additional use in enabling the boat to return to the surface. M. Doré, a lieutenant, went for several trips in this manner near Rochefort. The *Plongeur* was 42·5 metres long, 6 wide, and 3 deep. Its form, similar to that of a fish, and its internal construction, are shown by a model in the Marine Museum.

D'ARSONVAL'S UNIVERSAL APERIODIC GALVANOMETER.

AT the sitting of the French Physical Society, on December 21st, M. A. D'Arsonval gave the following description of his universal aperiodic galvanometer:—

Like Wiedemann's compass, this galvanometer is a tangent compass, with movable bobbins; but it presents numerous modifications, which simplify the manipulation of it, and render its employment much more general. Its construction enables it to be rapidly transformed into an astatic galvanometer, of the Nobili type, or into a Thomson galvanometer. For this all that is necessary is simply a change of the magnetic gear.

The original idea consists specially in having rendered the part bearing the gear movable and independent of the base supporting the bobbins and the graduated scale along which they move. The amortisseur itself is also movable. It may be taken away without touching the magnetic gear, completely suppressed, or replaced by mechanism rendering the damping effect variable at will, passing gradually from a maximum to zero.

He describes separately the two parts of the apparatus—(1) the fixed part or base, (2) the movable part (magnetic gear and damper).

Fixed part.—This part, made entirely of brass, consists of a circular tray resting on a point and two supporting screws. A graduated scale, 50 centimetres long, passes through the tray following the diameter perpendicular to the line joining the two supporting screws. On a second diameter, perpendicular to the first, are two rods connected at the top by a cross-piece with a circular aperture 5 centimetres in diameter. Upon this orifice, as upon a centre, the second part of the apparatus rests and is pivoted.

The centre of the tray divides into two parts of equal length the graduated scale which is fixed to it edgeways. Each half of the rule receives a movable cap which can slide all along it, as upon a Melloni frame. Each cap has on its upper part a circular bobbin, which is fixed to it vertically by means of a central screw, moved by hand, which permits of a rapid changing of the bobbins according to the nature of the currents to be measured. Each bobbin has engraved on its outer surface the number of turns and the resistance of the wire wound round it.

It being necessary for the graduated scale to be perpendicular to the magnetic meridian, we merely place the points of the two supporting screws on a line traced in this meridian, and the apparatus is ready.

Movable part.—This consists of a cylindrical barrel of brass, arranged vertically, and pivoted at its base upon the circular opening in the cross-piece connecting the two rods. This cylinder is pierced laterally with a square opening, closed by a glass which is flat, movable, and slightly inclined, showing the mirror surmounting the magnetic apparatus. In the centre of the upper end of the cylinder is a vertical metallic tube, in the free end of which is a movable stopper surmounted by a winch on which is wound the wire supporting the gear; this wire descends into the tube, and bears at its lower extremity a little hook, on which the gear is hung after the glass of the cylinder has been taken away. Along this tube slides a regulating magnet, after the usual construction of the Thomson galvanometers.

The centre of the lower end of the cylinder also bears a tube having at its free extremity a screw stopper, on which is screwed the sphere of copper forming the damper. The centre of this sphere passes through the horizontal line joining the centres of the two movable bobbins. All these parts form a fixed whole, composed exclusively of revolving parts, having the same centre for itself and the fixed tray. The magnetic gear consists of a little U-shaped vertical magnet, 15 millimetres long and 6 from one side to the other. It weighs barely 2 grammes, and can carry from 100 to 120.

This magnet is much more powerful than Wiedemann's ring; it involves no displacement of the poles, and penetrates with the greatest facility into the sphere composing the damper, which has a vertical cylindrical cavity hollowed out in it to receive the magnet. The damper can thus be removed with the greatest facility without touching the magnet. This magnet is screwed to an aluminium wire, which penetrates into the cylinder. The extremity of this wire opposite to the magnet catches lightly in the frame of the mirror, which can thus receive all the orientations in the plane of the magnet. As the cylinder bearing the transparent glass is itself movable upon its centre, we see that the mirror can be directed into any azimuth, the movable magnet remaining always in the plane of the magnetic meridian.

It is easy to place a second magnet similar to the first on the same rod, reversing the poles, thus constituting a Nobili magnetic gear, if we do not wish to astaticise by means of the directing magnet according to Haüy's method.

The apparatus is very quickly transformed into a Thomson galvanometer by a simple change in the gear. Thus we have the three forms of galvanometer united in one, with the great advantage of being able to make the sensibility vary at will by separating the bobbins, and also of being able to make a differential apparatus.

M. d'Arsonval also calls attention to the fact that this galvanometer, furnished with its damper, makes an excellent ballistic measuring apparatus, which returns to zero without oscillation, a very precious quality in taking measurements very rapidly.

He cannot dwell here on the modes of measuring electromotive forces, resistances and capacities; all these measurements are taken with the greatest facility. By using the micro-metric scale which M. d'Arsonval presented to the Academy for the reading of small deviations, we get a tangent compass of the greatest accuracy. For these various reasons he has thought it best to call this instrument a universal aperiodic galvanometer.

These successive modifications, the necessity of which became evident to him in his daily experience, were made at M. de Brauville's factory.

ELECTRIC LIGHTING IN PARIS.

LAST week we gave the names of the companies which had had districts allotted to them. The following are the regulations governing these companies :—

The concessionaire is authorised to place in the ground, under the causeways and footways, in the section handed over to him, wires for the transmission of the electrical current. The installation of these wires will take place under the supervision of the Administration, which can oppose it under certain conditions. The wires will only be installed under the causeway in order to cross the roads, and in these cases they must be placed at least a mètre below the surface. The duration of the authorisation is eighteen years, on and from the date of the notification of the decision signifying approval. This authorisation comprises neither monopoly nor any privilege whatever, the Municipality of Paris reserving to itself the absolute right of according other permits even within the extent of the districts already conceded. The concessionaire will be allowed to fix his own tariff, provided he does not exceed 4½ centimes per carcel hour and 45 centimes for an amount of electric energy equivalent to one horse-power per hour.

The Municipality reserves the right of revising, every five years, the maximum tariff and of lowering it, taking as a basis progress of every description which shall have been made in the electrical industry, either from the manufacturing point of view or from that of net cost. The new tariff will be fixed by the Municipal Council on the report of a consulting committee of four members : two to be appointed by the Council and two by the concessionaire. In case of their failing to agree, a fifth expert to be nominated by the committee. All the reductions of tariff granted by the concessionaire to his subscribers will be regarded as receipts up to the expiry of the authorisation and the tariff will not again be raised. The concessionaire will have to furnish electricity to whoever may demand it, over all the district of the distribution cable, except during the last three years of the concession. He is absolutely interdicted from obtruding himself upon subscribers for indoor installations. The concessionaire will pay to the city a rent of 100 francs per year for each kilomètre or fraction of a kilomètre of conductor laid down. Further, the city will made a deduction of 5 per cent. on all raw materials used in working. In case of the works in which the electricity is produced being situated outside Paris, this deduction will be raised 1 per cent., representing the amount of the octroi dues on the coal employed.

The authorisation will be withdrawn : 1. If the concessionaire transfers to a third person all or part of his rights and obligations, without an express authority of the Prefect after consulting with the Municipal Council. 2. If he have not commenced working six months after the date of the authorisation ; and if within a period of two years he is not in a position to satisfy requirements over all parts of his district where canalisation is obligatory. 3. If for the other portions of his district he does not lengthen his canalisation every time the demands attain 750 watts per 10 metres of conductor.

The City reserves to itself the right of purchase at any period after the expiration of the first 10 years of the concession. This purchase will be effected by taking as annuity payable to the concessionaire up to the expiration of the concession the mean of the net yield of the three years preceding the year of purchase. The canalisation, machinery, &c., will be bought by the City at an expert's valuation.

Finally, the concessionaires must not employ more than one-tenth of foreign workmen. The day's work is to be nine hours. The salaries of the electricians and mechanicians is fixed at an hourly minimum of 80 centimes from 6 in the morning till 6 at night, at 1 franc 20 centimes from 6 at night till midnight, and at 1 franc 60 centimes from midnight till 6 in the morning. These rates of payment will be revised every five years. *All machinery, wires, and apparatus employed must be exclusively of French manufacture.* Under pain of forfeiture, the concessionaires must be able within two years to supply electricity throughout the districts indicated by us last week. The streets within these limits will be, as is set forth in the Council's plans, lighted in proportion to the demands.

Such is the present position of private lighting. Further, there are the municipal electrical works, voted but not installed, which will be placed at the Halles, and will supply the electric light to certain parts of the first and second arrondissements. For lighting the public streets the question is in a much less advanced stage. At its sitting of the 31st ult. the Council voted a sum of £8,000 for the lighting by voltaic arc of the main boulevards during the Exhibition, but is is probable that this attempt will be nothing but an experiment similar to those which took place during the International Exhibition of 1878, and in any case it is still only a question of the lighting of a few of the great thoroughfares. That the replacing of gas by electricity will not be effected so quickly appears to be the general opinion of those in Paris who are qualified to form an opinion.

NEW WHEEL-ARMATURE DYNAMO MACHINE.

[A COMMUNICATION FROM ABROAD.]

THE number of new dynamos appearing yearly is extremely great, so great that we cannot possibly expect to find that all these novelties are, at the same time, improvements.

The dynamos which at present can really be called good are almost all constructed on the old, well-tried types of a few firms. It is natural that these machines have been improved in the course of years. Their construction shows undeniable improvements, which appear both in an electrical point of view and in manufacture.

But as regards the novel dynamos which are almost all variations of known models of ring or drum machines, there can scarcely be recognised any advance, or any step towards original construction. The want of real improvement is scantily masked by the refined devices which are cherished in the arrangement of the armature coilings, and the consequent complicated structure of the commutators, as well as by arrangements of the magnetic field in the recent construction of dynamos, often not easy to be explained. By the present craving to produce simply "something new," we have remained so far behind that the construction of dynamo machines cannot lay claim to the name of "machine building." It cannot, however, be denied how great are the disadvantages which thus arise. The rapid spreading of the technics of electric lighting is devoid of a natural basis so long as we have no construction of dynamos which is sound, theoretically and practically. This weak point in our modern technics is rarely recognised, even among specialists, as is daily proved by new undertakings, both in the field of electro-metallurgy and in electric lighting, both dependent on the construction of dynamos.

As some excuse for this, however, we will admit that we should not have handled so ruthlessly the above-mentioned defects if we had not been brought by facts to the conviction that the first great step towards amendment has been taken with the construction of the *wheel armature dynamo* (Fritsche's patent).

The machine shown in the fig. is at first glance very little different from well-known types. It appears as a variation of the multi-polar disc machines.

We are thereby tempted to suspect that the patentability of this machine, as of so many others, lies in some unimportant nicety. Such, however, in fact, is not the case, for the German patent, No. 45,808, granted to the engineer, W. Fritsche, of the firm of Fritsche & Pischon, of Berlin, is for the peculiar construction of the armature of the machine. In the title we have called the machine, as do the firm which constructs it, the *Wheel Armature Dynamo*. This name gives us the desired clue to the constructive specialities of the machine. We shall prefix to our report some brief remarks on Fritsche's patent.

The wrapping claimed owes its origin to the attempt at simplifying the drum-armature wrapping. It culminates therein that by the introduction of single rods its execution has become possible on the covering of a cylinder without utilising the front surfaces.

It is not intended to discuss the immediate advantages of this wrapping for the construction of drum, or rather cylinder armatures, but to treat of the eminently far-reaching import which the transfer of the plan of wrapping of the cylinder to the disc, or, better, wheel armature has effected. The wheel-armature, as carried out in the machine here represented, owes its origin to the new method of wrapping. The constructor calls the armature not a disc but a wheel, for according to the patent specification it is possible to construct this armature without core, without cotton insulation, without copper, and without any peculiarly arranged commutator, and in this point culminates the important advance of the improvement. The wheel-armature is incombustible, and takes the form of a grating of fine wrought-iron rods, separated from each other by the best insulating material, that is by air. Organic insulators, which are liable to become charred or even burnt have been entirely dispensed with. Thereby, by the peculiarity of the wrapping, no complicated introduction of rods and no connection with a peculiar commutator are necessary, but the rods of the wrapping are continued as commutator segments. It is important that the armature for any given number of poles gives off a current at two points only.

Each word which we have used in characterising the wheel-armature opens out a prospect hitherto unimagined on to the new construction of dynamos. The avoidance of insulation with cotton for the armature, and, indeed, of organic matter altogether for the insulation of the electric conductors of which the armature is composed, must reconcile every mechanician to the dynamo, and satisfy every electrician concerning the utilisation of the iron whereby the magnetic resistance which copper presents, and which hitherto seemed to stand in the way of disc machines, is obviated.

We are not in a position to enter even with approximate completeness into the significance of the new machine and the interesting details of its construction. We seek for the present merely to call the attention of specialists to its merits.

We add to our brief report that we have not here to do with an interesting experiment, but that the complete machine (a relatively large type) is already at work, and justifies the most sanguine anticipations.

The firm Fritsche and Pischon, founded a year ago, has in this short time overcome all the difficulties of construction encountered in building a machine which deviates so completely from all established precedents. The firm is now entering upon the construction of such machines upon a large scale.

Though in the interest of your readers we could have wished to give an earlier report on Fritsche's patent, we must, on the other hand, recognise the justice of the principle here observed, that nothing should be published concerning novelties until actual experience can be brought forward. We conclude in the conviction that in view of the surprise which the firm Fritsche and Pischon have occasioned to specialists the closest criticism of the construction of dynamos was justified.

THE SPRAGUE ELECTRIC ROAD AT BOSTON.

THERE have been several trial trips made over this railway between Boston and Brookline, to test the apparatus, which has been found to be perfect, and the road, says *Science*, will be put into commercial operation in a few days.

The West End Street Railway of Boston, of which this road is a part, is the largest street railway in the world. It extends over 212 miles of track, using 1,700 cars, and more than 9,000 horses. The president of the West End Street Railway Company, Mr. Henry M. Whitney, of Boston, is universally recognised as being one of the most enterprising and successful street railway men in the country, and, aided by an efficient corps of assistants, has succeeded in giving Boston since his administration the most efficient street railway service which ever existed in that city.

Before deciding upon any electric system to be adopted upon the West End Road, President Whitney, accompanied by members of the board of directors and managers, visited all the principal electric railways in the country operated upon the various systems, including visits upon three different occasions to Richmond, Va., to inspect the famous electric road in operation there upon the Sprague system. After a most careful examination of all these different roads, the contract for equipping the West End Road was awarded by the board of directors to the Sprague Electric Railway and Motor Company of New York.

The system of electric railway called for in this contract is wide and comprehensive. The main line from Boston westward, beginning at Park Square, will run down Boylston Street bridge, and then down Chester Park to Beacon Street. It will then proceed over the Beacon Street extension to the Chestnut Hill reservoir, and to Allston, and Oak Square, Brighton. From the East Park gate, over the new boulevard to the Chesnut Hill reservoir and Brighton, the Sprague overhead system will be adopted; in the more crowded streets of the city the Bentley-Knight conduit will be used, and the Sprague cars will run over the whole system.

The power station from which the electric current is distributed to the line is situated on Braintree Street, Alston, near the Boston and Albany Railroad, and also at the edge of the water, thus giving both water and rail facilities for fuel. This building, which is the most perfect electric plant of its kind in the country, is situated very nearly equidistant from the extremities, and is therefore literally a central station. The station, with the adjoining car-house, is of brick, and completely fire-proof.

In its construction, it was the aim of the West End Company to get the best in every detail. The chimney stack is 100 feet high. The boiler-house, which is both convenient and commodious, is at present equipped with three horizontal tubular boilers, furnished by the Jarvis Engineering Company. The engine room contains two high-speed automatic cut-off engines of the Armington and Sims pattern, of 200 horse-power each. Each drives two powerful dynamos of 80,000 watts each, and wound for a maximum pressure of 500 volts. These dynamos are of the highest efficiency and simplest construction, and, if need be, can be placed under the charge of the steam engineer. The dynamos feed into copper wires, supported on the walls by porcelain insulators.

Each machine has its independent ampèremeter, and in addition there is a general ampèremeter at the end of the positive bar. From this bar the current passes to special snap-switches, each switch being connected through a three-plug safety switch back to one of the feeders supplying current to the main line-wire. These feeder-wires tap into the line wire at different points on the line of road, thus maintaining the pressure approximately equal all along the line. At the ends of the feeders in the central station, pressure-indicators are attached, which indicate the voltage at the junctions of the feeders with the main current wire.

The engine room is brilliantly lighted by handsome hanging electroliers, each of which has five incandescent lamps. A switchboard at one end of the room furnishes an independent control for each group of lamps. All the surroundings of the machines are kept in the neatest condition.

Adjoining the power-house, but separated by thick brick walls, is a commodious house for accommodation of cars, 107 feet long by 80 feet deep, designed to hold 24 cars.

The overhead system, which is built under the Sprague patents, is of the finest description, and includes iron poles set in concrete throughout the entire length of the road. These poles are of a very neat and tasteful pattern, and support the span-wires which carry the trolley-wire at a height of 18 feet over the centre of the track. This overhead wire, which is used for a working conductor, is made of silicon bronze, of the small Sprague type, only three-sixteenths of an inch in diameter. This is the only wire suspended over the middle of the track, and its lightness and high tensile strength allow the overhead supporting structure to be of the lightest description possible. The poles are 125 feet apart.

The return circuit is through the rail, and thence by both metallic and ground circuits to the station. Each section of rail is joined to copper ground wires throughout the length of the road underneath the string-pieces. At intervals of 500 feet this ground wire is connected to an earth plate, and at seven points widely distributed. The ground wire is connected to the station, and there is also a main ground connection made there through a large sink-plate.

In the overhead system a new method of switching has been adopted, which is at once ingenious and simple. Five or six feet inside the turnouts a small switch with flaring rider is interpolated into the main and branch wires, and a spring tongue upon this directs the path of the trolley with absolute certainty and ease. By this means switching is made very easy, and all danger of the trolley leaving the wire is obviated.

The cars can be run at widely different speeds, varying from the slowest crawl to 12 or more miles per hour. They can be started and stopped without the use of brakes in the space of three or four inches, and when making the normal running speed, can, in an emergency, be stopped and reversed without brakes within less than a quarter of a car length. This is especially advantageous in crowded thoroughfares, and shows the superiority of the electrical car over the horse or cable cars. The control over the car seems marvellous, for one sees little or nothing save an almost imperceptible movement of the hand of the motorman; and the starting, although prompt, is very gradual and without shock or jar. The ordinary driver can operate one of these cars without the slightest trouble, after a very brief instruction. The saving on the operating cost of the Sprague system, owing to the superior quality of the apparatus over an ordinary horse-car line, constitutes a no inconsiderable item. It has been found that the average cost of motive power per car a day throughout the United States—that is, for from 10 to 11 hours, and trips aggregating from 45 to 50 miles—is about $4, and this counts only those horses on actual duty on the road. The cost of motive power per day per car for equal mileage in Richmond is less than $2 on the heaviest sort of grade-work, and at Boston it is estimated that even this low cost of operation will be reduced. For winter use upon this road the Sprague Company is equipping three electric "working cars," furnished with snow-ploughs, brushes, ice-cutter, and salt-distributer, and each propelled by two powerful 30 H.P. motors. In front of the car is a revolving wheel which breaks up the snow-crust completely, and behind are revolving brushes which sweep the tracks clean. It is estimated that this "working-car" will clear a street railway track after a heavy storm more quickly than the ordinary snow-plough drawn by 12 horses.

The system of wiring which the West End management has adopted for the crowded city streets is the Bentley-Knight conduit, now in use in Allegheny City, Penn. Here the conduit is laid midway between the tracks, and is strongly bolted to the stringers and sleepers. Its cross section is about a foot square, and its upper part has a slot similar to that used in cable railways; its width, however, being only five-eighths of an inch, giving an opening so small that carriage wheels will not catch in it. Besides this, it is so bevelled that horseshoe calks will not be held in it. Copper bars an inch and a quarter thick, one on each side of the slot, firmly insulated beneath it, carry the current—one from the dynamo, and the other returning from the motors. The current is taken from the conductors to the motors by "ploughs," as they are called, two to each car. These ploughs are thin iron plates about 10 inches square, hung from a framework over the middle of the track, and projecting into the slot. The motors are connected by controlling switches, and the car is operated substantially as is the overhead system. The ploughs are so arranged that they can be lifted out of the slot when any obstruction is reached. The current is taken up and returned by spring-plates, which slide along the copper conductors at the bottom of the plough.

In switching, two ordinary tongue switches are used, one in the conduit, and one on the rail. Brushes attached to the snow ploughs and cars easily keep the conduit and tracks clear, even in the severest snow-storms, or in case of slushy and muddy weather.

The change from the overhead system to the conduit is made while the car is in motion, and without the slightest delay in travel or inconvenience to passengers, so that the Sprague cars run over the entire distance.

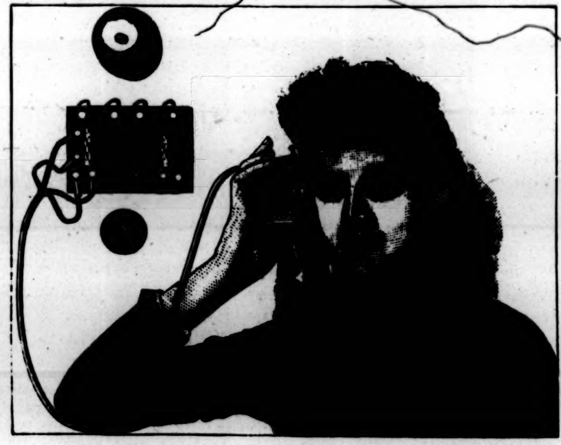
The kind of truck used upon this road is the latest Sprague improved truck. The equipment of this truck includes the new Sprague "Boston" motor, which will be used, for the first time in commercial work, upon this road.

THE LOWTH TELEPHONE.

THIS is a new and in some respects remarkable instrument, by which speech is transmitted without making use of sound waves as in the Bell and other forms of electrical telephones.

In the Lowth telephone the transmission is effected by means of an electrical plug which is placed against the neck of the operator, near the vocal organs. The vibrations of the neck, produced by the act of speaking, shake or move the plug, thereby giving rise to corresponding electrical undulations, which pass over the wire to a receiver at the opposite end of the wire, and are there heard by the listener. A receiver and plug are both combined in one instrument, as shown in our engraving, which is from a photograph, and the telephone is used in the manner there represented. The instrument is held to the ear with the plug resting against the throat as shown. The operator then speaks, and the voice is heard at the other end of the line with the utmost clearness.

It is claimed that this new telephone is entirely distinct from what is usually called the Bell system, as the instrument employs no diaphragm, and is not operated by atmospheric or sound waves, but by the muscular vibrations that precede and also accompany the utterance of words and other sounds. These vibrations are imparted to the button which is held against the exterior surface of the throat, and conducted by proper mechanism connected therewith to the electrodes or current-controlling elements, thereby causing the distant receiver to reproduce the words or other sounds.



Another valuable and peculiar feature of this instrument is that the operator may be surrounded by all manner of loud noises and only his voice will be transmitted, and then he may speak almost in a whisper. This is a very valuable quality, as city lines are generally troubled with induction, accidental disturbances on the diaphragms of transmitters of the common type furnishing their full share of the load. This new method shuts out all accidentals.

James Lowth, the inventor, was the first and has been the only experimenter in this field, and to his efforts and exhaustive experiments is due the present perfection of the system, which is now controlled by the Lowth Stetho-Telephone Company, of Chicago. This novel device will rank among the most curious and wonderful of inventions.—*Scientific American.*

SIR WILLIAM THOMSON'S ADDRESS.

IT is refreshing to find Sir William Thomson laying so much stress on the necessity of electrical engineers being really engineers. At present the average electrical engineer is not an engineer at all. He is simply anybody who may have drifted into the profession.

Now that the society has altered its title, it is to be hoped it will try and alter its character. To begin with, it might have a few electrical engineers on its council. At present the council is largely composed of instructors of youth in ether and molecules rattling together, and army men. A large proportion of the regular speakers at meetings are out of place, and should be carefully removed to the Physical Society, or anywhere else.

The theme is so large, that we cannot venture to discuss it here. Three-quarters of the breakdowns that have occurred have been through engines or boilers or belts going wrong. A cry is raised: "It was not the electric light, it was the engines." Not at all; it is the electric light engineer who is to blame. We could write a ream about this, but we won't just now.

Sir W. Thomson gives a table that will be a boon to electrical engineers when they come into existence. We refer to the loss of power in alternating current leads. The question has been studied by Heaviside, and we have somewhere a paper by Stefan on the same subject; but the treatment is disagreeably mathematical, and Sir W. Thomson's results in tabular form will give one some idea whether the waste of power due to uneven distribution in a given lead is one watt per 100 yards, or a horse-power per inch.

We wish Sir William had said a little more on the question of curls. We could not attend the meeting and it is difficult to tell from the report if he merely objects to the term curl. It was, we think, changed in Maxwell's second edition, but it is not at hand to look up. Much more probably Sir William objects to the growing use of quaternion methods, and it is much to be wished that he should give his reasons, as the opinion of such a very physical mathematician would be of the highest value. Mathematics are regarded from several points of view. Their chief object is the passing of examinations.

Their next object—pure mathematics—is nothing in particular. You merely work the figures about and get more figures, a sort of game of whist with triple dummy. Mathematical studies are laid out to train the mind—to train it, that is, for more mathematics. Another secondary object is to make you Astronomer Royal. The practical man who wants physical applications says, "A plague on all your houses," but finds all the available books suffering under University influence. We don't know if quaternions are now included for tripos, as we never went to Cambridge; but, if they are, no doubt books on electricity will go further than Maxwell, and we shall all have to study the subject and remember which direction is right-handed in the different books. We think that Minchin, as well as Clifford and Tait and Heaviside, is bringing Quaternions into commercial use, but his books are with Stefan's paper, and we are not going to look them up at this time of night. Quaternion methods are often more easily imagined. For instance, if reading in the train we come across a problem in the cartesian system with about four sets of direction cosines one gets mixed, and the passengers think it odd if we fix a thread to an internal corner, and build up perpendiculars against the floor, window, and cushion, and so on, to clear things up.

We always feel a dread that readers of an address like that of Sir W. Thomson will get into the way of confusing theories with working hypotheses. In electricity the tendency towards regarding ether and molecules rattling together as existing objects is greater than in many other branches of science. Everyone who aspires to be an electrical engineer, or even the father of an electrical engineer, should read Stallo.

The Metropolitan Board of Works and the Electric Light.—At the meeting of the Metropolitan Board of Works last Friday the following recommendation of the Works and General Purposes Committee was agreed to:—"That Messrs. Latimer Clark, Muirhead & Co., on behalf of the St. James and Pall Mall Electric Light Company, Limited, be informed that the Board do not, so far as they are concerned, offer any objection to the proposal of the company to lay electric light mains in Duke Street, St. James's, and certain other places in that neighbourhood, as shown on the plan accompanying their letter."

NOTES.

Electric Lighting in the Royal Navy.—The twin screw special service vessel, *Traveller*, has been fitted with the electric light at Portsmouth. The installation underwent a trial on Saturday. The *Cossack*, cruiser, had her electric lighting apparatus satisfactorily tested at Keyham a few days ago, under the direction of Commander C. G. Dicken, from the Admiralty, and Mr. J. Welsh, assistant constructor, in charge of the electric fittings at Devonport.

Electric Lighting at Eastbourne.—Last week, by the invitation of the Mayor of Eastbourne (Alderman Boulton), who is also chairman of the local electric lighting company, members of the Hove Commissioners visited that town and were shown over the electric lighting works in Junction Road by the directors and resident engineer. The visitors expressed great satisfaction with what they had seen.

The Strand and the Electric Light.—At the meeting last week of the Strand Board of Works the lighting committee reported that they had considered applications for provisional orders from the Metropolitan Electric Supply Company, London Electric Supply Corporation, House-to-House Electric Supply Company, Electrical Power Storage Company, and from the Westminster Electric Supply Corporation. They (the committee) considered that the two first-mentioned companies only were in such a position as would render it prudent for the Board to enter into negotiations with a view to one or other, or both, of such companies supplying electricity to the district. The first-named company, the Board, by the adoption of one of the reports of the committee, had already viewed with some favour; but with reference to the second it appeared to feel strong enough to carry the provisional order it had launched, and therefore was not prepared to make any arrangements with or concessions to the Board. They recommended, however, that the clerk should be directed, in conjunction with the Parliamentary agents, to present objections to the Board of Trade against the granting of provisional orders to all the above-mentioned companies. Dr. Sandwell, in moving the adoption of this report, said that it was only a preliminary report of the committee, who would further consider the matter in the course of a few days. The report and recommendations were adopted.

Morecambe and the Electric Light.—At the meeting of the local board last week a letter was read from Mr. Darlington, solicitor, Bradford, asking what steps the Board proposed to take with reference to a notice served on them in October last by Messrs. Andrews & Preece, electrical engineers, Bradford, of the intention of the latter to apply for a Provisional Order for electric lighting within the district of the Morcambe Local Board. The Clerk pointed out that the notices had not been issued at the time specified by Act of Parliament, and that the promoters had submitted no plans or particulars of the system proposed to be supplied by them, and the Board resolved that 'they could not assent to any scheme until they had full particulars before them. At the same meeting the Board also decided to object to the motive power on the proposed Morcambe and Lancaster tramway being other than animal or electricity.

Electric Lighting at the Perth Dye Works.—Messrs. P. and P. Campbell have just introduced two new alternating current dynamos in connection with the electric lighting of their works. These machines have been erected principally for the purpose of securing light in case of a breakdown of the large engines. Eight arc lamps have also been fitted up in the dye house. Messrs. Campbell have now 40 arc lamps and 100 incandescent lamps in their works. Messrs. Normand and Sons, Limited, Glasgow, fitted up the machines and the lamps.

Electric Lighting at Southampton.—At the last meeting of the Southampton Town Council a report was presented by the Special and General Roads and Works' Committee with reference to the correspondence which has taken place with the Local Government Board and the Board of Trade on the subject of electric lighting. At a meeting held on November 27th, the Town Clerk submitted a communication, dated November 22nd, from the Board of Trade, enclosing a copy of a letter from the Local Government Board as to the necessity of the Corporation obtaining powers under the Electric Lighting Acts, 1882 and 1888, in order to carry out certain electric lighting works, and instructed the Borough Surveyor (Mr. Bennett) to prepare a farther report upon the subject. On December 8th the committee again met, when Mr. Bennett's report on electric lighting was under consideration, and the surveyor pointed out the amended route he proposed to adopt for carrying the electric wires. It was then decided to recommend the Corporation to adopt Mr. Bennett's amended report and plan, to carry out the works in accordance therewith, and to make the necessary application to the Local Government Board for their sanction to the same. At a further meeting of the committee, held on January 18th, a letter was submitted from the Board of Trade on the proposal of the Corporation to light certain streets with the electric light, and enclosing a copy of a further letter from the Local Government Board, reiterating a previous opinion as to statutory powers. The committee expressed their opinion that it was unnecessary and undesirable to obtain statutory powers. This view was endorsed by the Council.

Bradford and the Electric Light.—The work of laying the cables for the electric lighting at Bradford is being pushed forward. The streets are being opened and made good by a large gang of Corporation workmen, the cables being placed in the trenches by the contractors, Messrs. Siemens Brothers. Where the cables cross a street brick channels are prepared for them to lie in so as to prevent damage by heavy traffic, but they are not protected in any way along the foot-paths, except that loose boards are placed above them before the ground is filled up. These boards are intended to warn workmen who may be opening the foot-paths in future that the cables are below. We trust that the warning thus given will always have the effect of diverting the workman's pick. Not very many years ago a gang of men working between Edinburgh and Leith unearthed a cast iron pipe which they could not account for. They broke the pipe and then put a spade through the "old rope" which was found inside. The "old rope" proved to be a telegraph cable, and the spade at once cut Leith off from the telegraphic world. Let us hope that the Bradford workmen will prove themselves to be more intelligent.

Theatre Lighting.—Electric lighting installations have been fitted up in the Tarzuela and Apolo Theatres, Madrid, so that now every theatre and circus in Madrid is supplied with the electric light. With the exception of the Opera House, all the installations have defects, *Industries*' correspondent states, and some require renewals of boilers, engines, or dynamos. The installations are also unsatisfactory, because, as a rule, no spare plant is provided, and should anything go wrong with the machinery, the building is thrown into darkness, a contingency which has already happened more than once.

Lighting of the S.S. "Dresden."—The fine new steel screw steamer *Dresden*, built and engined by the Fairfield Shipbuilding & Engineering Company, Govan, for the North German Lloyd Company, went on her trial trip on Saturday, in splendid weather. She is a vessel of 5,000 tons, and is lighted throughout with electricity, for which purpose she has two distinct engines and duplicate dynamos, each furnishing power of about 300 incandescent lights.

The House of Commons and the Electric Light.—An extension of the system of electric lighting is in progress at the House of Commons. Hitherto the only portions of the building illuminated by electricity have been the division lobbies and upper corridors, the library, reading-room, tea-room, smoke-room, and a limited number of other apartments, but when the House re-assembles it will be found that gas has also been superseded in the cloak-rooms and entrance lobbies, and on the main staircase. It is understood that this is the first step towards the general adoption of the electric light at St. Stephen's, and that before long the oil lamps used in the committee-rooms will be abolished, and electricity substituted for gas in the public corridors and waiting-halls, as well as in the members' lobby.

Westminster and the Electric Light.—At a meeting of the St. Margaret's and St. John's (Westminster) Vestry, on Wednesday last week, the Works and General Purposes Committee reported that they had before them a proposal by the Kensington Court Electric Lighting Company, offering, with a view to the general adoption of electricity in place of gas in the more important thoroughfares of the Knightsbridge district, to light up the lamps at Hyde Park Gate for one month free of charge, after which period it would be prepared to enter into an arrangement for the permanent supply of current to these and other lamps which the vestry might decide to have so lighted. The cost of the lighting would be based on the experiment. The committee recommended that the application be granted, subject to the company holding the vestry harmless against any loss or expense, and on the direct understanding that they were not committed to the continuance of the light. Provision should also be made for the company to light the gas in the lamps in the event of the electricity failing. The report and recommendation were agreed to.

Swansea and the Electric Light.—From a South Wales contemporary we gather that the Swansea Harbour Trust intend enlarging their present electric lighting plant; they have decided to light their docks, harbours, warehouses, offices, &c., for an outlay of £2,000. Their present plant, we believe, consists of a "Brush" installation of some 20 arc lamps, which, though somewhat old-fashioned has given every satisfaction. We think, however, that before the Swansea Harbour Trust commit themselves to the Brush Company it would be only fair to the shareholders, whose money is to find the above extension, that a little wholesome competition be introduced, so as to give other equally deserving electric light companies an opportunity of competing; this would, no doubt, mean a saving of money.

Electric Lighting of Trains.—The adaptability of electricity for the illumination of railway carriages has been discovered in South Africa, and on an evening in December, in response to an invitation from the General Manager of Railways, a party of gentlemen travelled from the Cape Town terminus to Muizenberg in a train so lighted. This pioneer train has been fitted up by the Electrical Department in the service of the Harbour Board, of which Mr. Elliott is chief. Mr. Smith, electrician of the Harbour Board, was responsible for the carrying out of the installation.

Pantomime by Telephone.—Through the system of the National Telephone Company, on a recent evening, the Bradford pantomime of "Blue Beard" was listened to in the office of the *Sheffield Telegraph*, the songs and choruses being particularly clear.

The Telephone in Kensington.—The United Telephone Company has opened its exchange for the Kensington district and a fair number of residents has subscribed, but, so far, considerable dissatisfaction with the system appears to be the chief result of the enterprise.

Tracking Criminals by Telephone.—Since the introduction of the telephone into Kent it has been found to be of very great service in the tracking of criminals. So much so that now nearly the whole of the police stations, Canterbury being the last added to the list, have been connected with the system wherever it exists. Instances of its utility in this respect are frequently occurring, and this week a somewhat amusing capture took place, through the instrumentality of the telephone, at Dover. A man who is supposed to be one of the "gentlemen" who have been committing a series of burglaries in Kent, went into a pawnbroker's with a part of his plunder and failing to give a satisfactory account of it a constable was called in and he was taken to the police station. It was there found that he answered to a description which had been telephoned from Folkestone, the result being that he was convicted and sentenced to two months' hard labour.

The Telephone and Fires. — The telephone has done good service in regard to fires when given a fair chance, but on the outbreak of a fire at Brixton the police were half an hour in telephoning to the fire brigade. Possibly there was no street telephone near the scene of the fire, but the promptitude with which the firemen turned out when called is a strong argument for increasing the number of street telephones liberally.

Fire at Chester Post Office.—Last Sunday morning a fire broke out in the Post Office at Chester by which a great deal of damage was done to a large number of valuable telegraph instruments. A staff of electrical engineers was quickly summoned from Liverpool, and these soon restored communication on the circuits which had been damaged.

Bankruptcy Court.—At the London Court of Bankruptcy last Friday morning, a statement of affairs was issued under the failure of R. Banner Oakley, of 124, High Holborn, electrical engineer, liabilities £25,612, assets £80. It appears, however, that the creditors will, with a few exceptions, be entitled to participate in a deed of assignment executed in May, 1888. The bankrupt was previously bankrupt at Rochester about 1873 or 1874, and again in London in January, 1876, when he was described as a banker, and he has not obtained his discharge. He attributes his present failure mainly to losses and expenses in connection with the Æolus Water Spray Company and the Clamond Incandescent Light Company. At a first meeting of creditors on Wednesday, Mr. J. S. Chapellow, 10, Lincoln's Inn Fields, was appointed trustee of the estate.

Institution of Electrical Engineers.—At the next meeting on Thursday, January 24th, 1889, a paper will be read on "The Insulation Resistance of Electric Light Installations," by Prof. Andrew Jamieson, F.R.S.E., M.Inst.C.E., member. Considerable reference has been made recently in our columns on this subject, and doubtless Mr. Jamieson's paper will meet with much appreciation.

The Electro-Harmonic Society.—For the concert on Friday next, several artists who have not hitherto appeared before the members of the Society have been engaged. Of these the best known perhaps is Mr. Radcliff, the eminent flautist, who has no superior in this country, although Messrs. Moore and Miles require no credentials. Two new songs will be introduced, one by Hamish MacCunn, a young Scotch musician who has recently acquired a great reputation as a composer of orchestral works, and another by that veteran song writer, Molloy. The programme contains fewer items than usual, but, as can be seen in our other columns, the selections are excellent, and a very enjoyable evening may be anticipated.

Removal.—Mr. A. A. Campbell Swinton has opened new offices at 66, Victoria Street, Westminster, where all communications to him should now be addressed.

Proposed Electric Tramway in Birmingham.—An effort is being made by the Birmingham Central Tramways Company to obtain the consent of the Public Works Committee and the Town Council to the practical application of electricity as a motor on the Bristol Road route. When the company acquired the line from Paradise Street to the borough boundary at Bournbrook one of the conditions of the tenancy was that the cable system of locomotion should be adopted by July 23rd, 1888. The tenancy, however, expired without the conditions having been complied with; but the time for the reconstruction of the line was, by permission of the Board of Trade, extended for a further period of 12 months. As this term of extension is rapidly expiring, it is obvious that the work must be taken in hand without delay, and the company, being alive to the fact, is now making an earnest endeavour to carry out the terms of the agreement. The agreement pledges them to the adoption of the cable system, but the expense of the construction would be so great that the directors doubt whether they would be justified in adopting that system through any but the most populous districts, and they have in many respects arrived at the conclusion that the laying down of cable lines along a suburban residential district like the Bristol Road would not be a commercial success. Under these circumstances the directors turned their attention to the feasibility of electric traction along the Bristol Road, and the recent experiments have satisfied them that that mode of traction would at the very least be worth a full and fair trial. Negotiations have been entered into between the directors of the Central Tramways Company and the electric company, and the result is that arrangements have been made, subject to the approval of the Birmingham Corporation, for the working of the Bristol Road route by electricity, at a cost which will compare favourably with the present cost of steam traction. The terms of the contract proposed by the tramway company would be that an agreement should be entered into for three years to work the line by electricity—that period being deemed sufficient to enable the Corporation and the general public, as well as the promoters, to discover whether the advantages of electric traction would be sufficient to make it desirable that that kind of working power should be applied on all the routes of the company in the place of steam. The question of approving of the electric motor is now under the consideration of the Public Works Committee, and measures are about to be taken to test the applicability of the motor by running an electric car on the various routes of the company for a period of one month.

Austrian Patents.—Mr. J. G. Lorrain, consulting engineer and patent agent, sends us the following:—In consequence of a recent decision of the Austrian Patent Department the grant of Austrian patents can henceforth be delayed by applying for it. This alteration in the practice has been adopted with a view to offer the applicants for Austrian patents who have also applied for U.S. patents the utmost security with reference to the uncurtailed duration of the latter, as the grant of the Austrian patent can in such cases be delayed until after the grant of the U.S. patent.

Catalogues.—Mr. S. Sudworth writes:—"The reply to my protest in your last week's issue from Binswanger & Co. is simply evasive, as I have not parted with my own right to manufacture, or determined who shall have the arrangement for theatre lighting and controlling. Therefore, I have no need to require any authority in calling attention to their endeavour to appropriate the arrangement."

Electric Light in Pantomine.—One of the scenes in the pantomine of "Red Riding Hood," at Cardiff Circus owes a great deal of its brilliance to arc and incandescent lamps, which illuminate a court ballroom, the apparatus being supplied by Messrs. Sydney F. Walker and Olliver.

The Schanschieff Battery in Brussels.—*Industries* correspondent writes:—"It is curious to note how, from time to time, public confidence in primary batteries for electric lighting revives. The latest example is an attempt made in Brussels to form a company for the exploitation of the Schanschieff battery." After stating what is claimed for the battery the correspondent continues:—"It is, however, somewhat doubtful whether the inventor will be able to preclude others from using a zinc carbon cell with sulphate of mercury, since this combination has already been patented in Belgium in 1881."

Forthcoming Publications.—Mr. Murray promises a collection of the scientific papers and discourses of the late Sir William Siemens, F.R.S., edited by Mr. E. F. Bramber, C.E., in three volumes. Vol. 1 will be devoted to Sir William's writings on heat and metallurgy, vol. 2 to his writings on electricity and miscellaneous subjects, and vol. 3 to his addresses and lectures.

Alkaline Accumulators.—Doubtless the writer of the article on the Desmazures-Commelin Accumulator will be recognised by the initials attached. We have several times recently alluded to these batteries, and we feel great satisfaction that an authority so well known as P.B.E. should so unhesitatingly commend them for tramcar traction. There is no reasonable doubt that the problem of the commercial success of electrical propulsion on tramlines has been solved, not only by these alkaline accumulators, but also by the new plates of Mr. Reckenzaun.

The Proposed Electric Railway.—Mr. W. Leatham Bright, M.P., is said to be a leading promoter of the Underground Electric Railway from St. James's to Holborn. The honourable member is a son of Mr. John Bright, and is a shipowner and colliery agent. Grave doubts are expressed in some quarters as to whether the scheme will be persevered with, or, in that event, be sanctioned. There is a good deal of opposition, and the first attack upon the project will take the form of the technical objection that sufficient notice, under the Standing Orders, was not given in the newspapers respecting the proposed route. As we pointed out last week, many of the property owners and tradesmen object to the scheme because they will have little chance of heavy compensation, seeing that the promoters do not contemplate acquiring much of the property overhead But, on the other hand, many owners and shopkeepers support the project as likely to bring custom to them. The general public ought to support the Bill to a man, in view of the great convenience such a line would afford.

Society of Arts.—The lecture next Wednesday evening will be by Prof. George Forbes, F.R.S., on "Electric Meters for Central Stations." Mr. W. H. Preece, F.R.S., will preside. For papers on "Secondary Batteries," by Mr. W. H. Preece, and "Arc Lamps and their Mechanism," by Prof. Silvanus P. Thompson, no dates have yet been fixed.

Reciprocal Appreciation.—Mr. J. W. Mackay has for the fourth time presented the staff of the Commercial Cable Company with a Christmas box of half a month's salary, and the staff in return have presented Mr. Mackay with a magnificent silver centre-piece or jardiniere, in commemoration of the fourth anniversary of the opening of the cables. The piece stands 19 inch high, and in its manufacture 480 ounces of fine silver were used.

Personal.—Mr. Samuel Vyle has occupied the post of Government Electrician in Demerara just one year, and in that time has succeeded in making himself exceedingly popular, judging from the newspaper accounts of his various doings. A month ago he gave a lecture, at which the Lieut.-Governor and Mrs. Bruce were present, on "Electricity at Work," which was much enjoyed, and was fully reported in the *Royal Gazette*, the enterprising daily paper of the colony.

Elmore's Copper Depositing Process.—We have just received the prospectus of "Elmore's Patent Copper Depositing Company, Limited," which is formed, with a capital of £200,000 in £2 shares, to acquire Messrs. Elmore's patents for manufacturing copper articles direct from rough copper bars. The first issue will consist of 70,000 shares, of which 23,000 will be allotted to the vendors as fully paid, as part of the purchase money, an additional £53,400 in cash completing the consideration. Nearly £100,000 for patent rights is a surprisingly large sum, but the process is backed up by excellent reports, Dr. John Hopkinson, F.R.S., and Prof. Geo. Forbes, F.R.S., in addition to Mr. W. H. Preece, F.R.S., Mr. W. Parker, Messrs. Clark, Forde, Taylor, and others, whose reports have already been made public, having given valuable testimony in its favour.

That Safe Luminant!—Mr. and Mrs. Headworth and their family, who live in Canada Street, Sheffield, narrowly escaped death by suffocation last week. The gas-pipe near to the main had burst, and filled the house with gas.

Glasgow Civil Engineers.—The first general meeting of the Glasgow Association of the students of the Institution of Civil Engineers was held on Monday night, when an interesting paper on "Electric Welding, and its application to the Arts," was read by Mr. Edward J. Duff, Wh. Sc., Stud. Inst. C.E.

Electric Automatic Supply Machine.—A new electric automatic supply machine has been invented by Mr. James Gilbert Cumming, of Edinburgh, by which large articles may be instantaneously sold and delivered to a purchaser at any price. An important characteristic of the invention is the capacity for dealing with a large variety of different or dissimilar articles. The purchaser, moreover, has every facility for seeing the article he desires to purchase, and is thereby placed in the same position as though he were purchasing from a salesman in a shop.

The "Peral" Torpedo Boat.—According to the *Daily News*, telegrams from San Fernando report that the naval authorities have offered Commander Peral an old wooden corvette for his experiments with his new submarine torpedo vessel. Up to the present the submarine vessel has not been out of dry dock. The inventor is superintending the last arrangements, such as the fitting up of the electric accumulators and air tubes, before the vessel is transferred to a larger dock, where the first attempt to launch her will be made next week. This will be carried out under the direction of Commander Peral.

Execution in New York.—A curious legal point has arisen in connection with the substitution of electricity for hanging as the mode of inflicting the death penalty in the State of New York. Henry Carlton was sentenced ten days ago to be hanged on February 3rd for the murder of a policeman. His counsel raised the point that hanging was abolished in the State by the Act passed in June last, and that in substituting electricity the Legislature expressly provided that it should be applicable only to murders committed on or after the 1st of January this year. Therefore, it is contended, Carlton cannot now be hanged, nor can he be put to death by electricity. The matter will be argued before the Court of Appeal at Albany, and in the meantime it is expected that the execution of the capital sentence in all cases now pending will be stayed until the appeal has been decided.

Telegrams for Spain.—In notifying us of the interruption of its Falmouth-Bilbao cable, the Direct Spanish Telegraph Company states that arrangements have been made by which telegrams for Bilbao, Madrid, and other places in Spain, can during the interruption be promptly forwarded by the Eastern Telegraph Company's route.

Another Electric Christmas Tree.—At Stourton Hall, Lincolnshire, Mr. J. M. Livesey gave on Boxing Day a treat to the inmates of the Horncastle Workhouse and the school children, at which a Christmas tree was illuminated by coloured glow-lamps, the large building in which the gathering took place being also temporarily lighted by about 30 lamps. On the 2nd January the lamps were re-arranged and again used on the occasion of the tenants' ball. The hall itself has been lighted electrically for the last 18 months, the installation having been put in by Messrs. Drake & Gorham. The engineer in charge is Mr. G. H. Carter.

Anti-friction Steam Packing.—Messrs. Cresswell & Son send us a copy of a catalogue in which their patent anti-friction steam packing is described. They claim for it that its use reduces friction to a minimum, and that by the introduction of certain compounds into the fibre it cannot become hard, even under the action of extreme heat and pressure. Another speciality of the firm is "Asbestchouc," a combination of asbestos and rubber, and used for sheeting, washers, tape, guage-glass rings, and the like.

A New Departure at Darlington.—Messrs. David Fox and Sons, of Darlington, who cultivate a trade in coffee, have just opened a branch establishment, at which coffee is supplied "of rare quality, sweetened, creamed and biscuited at twopence per cup." This establishment has been lighted by Messrs. Cox-Walker & Co. by means of a Gramme machine, driven by a Beck gas engine without accumulators, and the novelty is said to prove very attractive.

Type Writing Contest.—The proprietors of the Remington type-writer being anxious to compare the speed of type-writers in this country with those in America, offered a number of valuable prizes, which were competed for at the St. James's Restaurant, Regent Street, on Wednesday evening. A goodly number competed, and in order to get through the competition before midnight, it became necessary to curtail the tests Mr. Mr. Oliver Wren, with a speed of 79 words per minute, won the first prize. Other competitors were well up, the winner of the fourth prize accomplishing 75 words per minute.

Obituary.—The death is announced of Sir William O'Shaugnessy Brooke, as having occurred at Southsea, after a short illness. Dr. O'Shaugnessy, who afterwards assumed the name of Brooke, was born in 1809, and was consequently in his 80th year. He graduated as M.D. at Edinburgh, and shortly afterwards joined the Bengal Army as an assistant surgeon in 1833. He was promoted to surgeon in 1848, and to surgeon-major in 1861. In 1852 he was appointed Superintendent-General of Telegraphs in India, and retained the post till 1862, when he resigned, and at the same time retired from the Indian Medical Service. He was the author of numerous works on scientific and engineering subjects, particularly one on the electric telegraph, published in Calcutta in 1839. For his valuable services in establishing a system of telegraphs throughout India he was knighted, and was also elected a Fellow of the Royal Society and of the Society of Arts. Sir William married in 1835, as his second wife, the daughter of Mr. Francis O'Shaugnessy, of Curragh, Co. Clare, Ireland, and his third wife was a daughter of Captain John Sabine. One of Sir William's daughters is the wife of Major-General Robert Murray, C.S.I., who served for many years in the Indian Telegraph Department, from which he retired as Director-General in 1883; and another daughter is the wife of Colonel Mallock, the present acting head of the department.

Electrical Automatic Delivery Box Company, Limited.—The petition for the winding up of this company was on Saturday dismissed by Mr. Justice Kay, by consent.

Electric Meters.—The New York *Electrical World* offers the following comments upon the paper of Mr. Jenks, a manuscript copy of which he so kindly forwarded to the REVIEW :—Although the most extensively used of all electric meters, there is probably none about the details of which so little is known among the rank and file of electricians as the electrolytic form adopted by Mr. Edison. What may, therefore, be considered as the first authoritative statement regarding the Edison meter, in actual practice, is that detailed in the admirable paper read before the American Institute of Electrical Engineers by Mr. W. J. Jenks. Of the many principles on which an electric meter can be based, Mr. Edison seems to have tried all which gave any prospect of success, and finally he adopted the one now in use. This search after a good meter is well illustrated in the description contained in Mr. Jenks's paper of a variety of forms, mechanical, electrolytic and other, containing combinations of different principles in their action. With the evident desire to forestall the criticisms which are usually made on the electrolytic meter, Mr. Jenks introduced into his paper an enumeration of the sources of error due to change of temperature, counter E.M.F. at varying current strengths, and variable resistance, and showed in what manner these were provided for in the Edison meter. Not the least valuable part of the paper is the testimony of those using the meter relating to its effectiveness in actual practice. On this point the opinion seemed to be unanimous that, so far as accuracy is concerned, the meter leaves little to be desired. And it is also shown that upon the score of expense of maintenance there seems to be a limit as regards the number of the lamps connected to a station, below which the metering system is not so profitable as the contract system. It is further shown that above this limit of lamps the addition of a meter to the system has a most marked effect in the decrease of consumption of current, and at the same time in a more than proportionate increase of revenue due to the fact that while under the contract system consumers are apt to use more light than is necessary, under the meter system they uniformly take care to turn out every lamp that is not absolutely required.

The Royal Society.—At the meeting for Thursday, January 17th, papers were to have been read by Dr. Gore, F.R.S., on "Relative Amounts of Voltaic Energy of Electrolytes," and by Prof. J. J. Thomson, F.R.S., on "The Resistance of Electrolytes to the passage of very rapidly Alternating Currents; with some Investigations on the Times of Vibration of Electrical Systems."

A Church in Darkness.—During service in St. Andrew's Episcopal Church, Kelso, on Sunday night, the gas suddenly went out, and the congregation was left in a condition of utter darkness, save the faint light which was shed from a candle placed at the side of the organ. The service was, however, proceeded with without interruption, and the light was shortly afterwards restored.

Sir F. Bramwell at Edinburgh.—Sir F. Bramwell delivered the inaugural address to the students of the Heriot Watt College, Edinburgh, last week, taking as a main part of his theme the career and achievements of Heriot and Watt. He afterwards dealt with the sacredness of economising coal, the use of water and other power in place of steam, electrical transmission of power, and electric lighting.

Electric Signalling on War Ships.—The *Central News* states that the Admiralty have definitely adopted into the service the engine room telegraph and electric signalling system known as Willis's patent, which will replace the mechanical system now in use. The Willis arrangement was subjected to the roughest practical test before its adoption. Its greatest advantage is that the engineer, on receiving an order, at once sends the signal back to the officer on the bridge, who is thus assured that his order has been correctly transmitted and understood.

NEW COMPANIES REGISTERED.

Newcastle and District Electric Lighting Company, Limited.—Capital £50,000, in £10 shares. Objects: To supply electricity for public and private lighting and other purposes, in Newcastle-on-Tyne or elsewhere in the United Kingdom. Signatories (with 1 share each): Hon. Charles A. Parsons, Elvaston Hall, Ryton; Sir Benjamin Chapman Browne, Westaire, Newcastle; J. D. Milburn, Ryton-on-Tyne; J. Bell Simpson, Ryton-on-Tyne; H. C. Harvey, St. John's Chambers, Newcastle; the Earl of Crawford, 2, Cavendish Square; A. F. Wade, 9, Albert Mansions, S.W.; W. M. Angus, St. John's Works, Newcastle; J. W. Spencer, Newton Street Works, Newcastle. Registered 14th inst., without articles of association, by E. Flux and Leadbitter, 144, Leadenhall Street.

Miners' Lamp Electric Lighting Company, Limited.—Capital £3,000, in £5 shares. Objects: To use patent rights for miners' safety and other lamps and wicks, and also for improvements in electric batteries, and in the application thereof to the lighting of miners' safety and other lamps, and for such purposes to adopt an agreement of 13th ult. between James Blackburn, F. Mori, and Osmond Yeadon Rhodes, of one part; and F. Eland, as trustee for the company, of the other. Also to carry on the business of safety lamp manufacturers and of an electric light company in all branches. Signatories: S. Stag Skepton, M.D., 21, Leopold Street, Leeds, 30 shares; G. Hobson, 30, Kingston Road, Leeds, 1 share; M. O. Jones, 31, Hanover Terrace, Leeds, 1 share; A. Lupton, 6, De Grey Road, Leeds, 5 shares; R. Bailes, Meanwood Road, Leeds, 5 shares; G. J. Lampen, Wakefield, 1 share; J. Clarkson Knowles, 10, Sanfield Street, Leeds, 1 share. Registered 12th inst., without articles of association, by Waterlow Brothers and Layton, Birchin Lane, Cornhill. Registered office, 71, Albion Street, Leeds.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Electric Tramways and General Syndicate, Limited.—An agreement filed on the 8th inst. provides for the issue to Hy. Davis Poole, of 33, Chancery Lane, or to his nominees, of 14 founders' shares in this company of the value of £5 each, the purchase price for the same to be 70 guineas, such purchase price to be allowed by the said H. D. Poole to the company out of the sum of £74 5s. now due and owing to him in respect of moneys advanced by him for the purposes of the company.

Akester Electro-Motor and Accumulator Company, Limited.—The annual return of this company made up to the 22nd February, 1888, was filed on the 9th inst. The nominal capital is £5,000 in £1 shares, the whole of which are allotted. Upon £1,500 shares 7s. 6d. per share has been called, and 3,500 are considered as fully paid. The calls paid amount to £392 and unpaid to £170 10s.

Newcastle-upon-Tyne Electric Supply Company, Limited.—The registered office of this company is at 141, Pilgrim Street, Newcastle-upon-Tyne.

Swan United Electric Light Company, Limited.—The registered office of this company has been removed to 100, Victoria Street, S.W.

CITY NOTES, REPORTS, MEETINGS, &c.

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended December 31st, 1888, states that the revenue for the half-year (still subject to revision on settlement with the French Company), after deducting out-payments, amounted to £34,188, against £23,002 17s. 6d. (after similar deductions) for the corresponding period of 1887 being a difference of £11,185 2s. 6d. in favour of the half-year under review, owing to the increased tariff in force since September 1st last.

The working and other expenses for the same period, including income tax, amounted to £16,475 6s. 9d., leaving a balance of £17,712 13s. 3d. as the net profit of the half-year. For the corresponding half-year of 1887 the working expenses and other payments amounted to £15,864 18s.

Interim dividends of 2s. per share for the quarter ended September 30th, 1888 (paid October 24th, 1888), and of 3s. 6d. per share for the quarter ended December 31st, 1888 (payable January 26th, 1889), together amounting to £16,695 5s., have been declared.

It having been demonstrated by an exhaustive trial over a period of more than two years that a 6d. tariff did not yield an appreciable profit, the tariff was on September 1st last raised to 1s. per word, by agreement between the Associated Companies (including the French Company) and the Commercial Cable Company. The result of the altered rates, so far, has been to reduce the volume of the traffic, but the receipts have been fairly augmented.

The repairs in the deep sea portion of the main cable to which reference was made in the 5th paragraph of the last report, were completed on the 8th August last, thus placing the cable in efficient working order throughout. The total cost of the repairs, including 218 knots of new cable used, amounting to £58,814 0s. 1d., has been charged to the reserve fund account. The cost of removing the cables and station from Torbay to Halifax (N.S.), and diverting cable from Brown's Bank, amounting to £23,638 10s. 5d., has also been debited to the same account.

A joint station (worked by this company) has been established by the associated companies at Boston, Massachusetts.

Arrangements have been made enabling the company to dispense with the Chester station, which was accordingly closed in December last, whereby a saving will be effected. This station was used solely for transmitting purposes.

The appeal of the Cie Francaise du Télégraphe de Paris à New York, mentioned in the last report, is still pending.

Mr. T. Finnis has been appointed secretary, and Mr. P. Oscar L. Moll traffic manager of the company, in the place of Mr. J. W. Fuller, who held both offices.

Western Counties and South Wales Telephone Company, Limited.

AN extraordinary general meeting of this company was held at the Grand Hotel, Broad Street, Bristol, on Wednesday, the 9th inst., Mr. Charles Nash presiding.

The Chairman said that last summer the question of raising additional capital was deferred, and now, after conference with the United Company, it had been decided to recommend the creation of £50,000 at 5 per cent. debentures. Of this amount it was proposed to offer for immediate subscription the sum of £30,000. It was with this object that he submitted the following resolution:—"That clause or article 71 of the articles of association shall stand as in the original articles, subject only to such variation that in place of the original sub-section (*a*) the following provision shall be inserted, viz.:—(*a*) They may borrow any sum or sums of money on such security and terms as to interest or otherwise as they may deem fit, and may secure the same by mortgage or other debentures or by bonds or other securities, or by any mortgages or charge of, or upon the whole or any part of any property, funds, assets, or effects of the company, including its uncalled capital, but so that not more than £50,000 be owing at any time without the consent of a general meeting, and provided that not more than £30,000 shall be borrowed without the consent of the United Telephone Company, and no borrowed money shall, without the like consent, carry interest at a higher rate than 6 per cent. per annum." He added that this arrangement would at any rate effect a small saving of interest. If, as they expected, these debentures were readily taken up, the interest would be 5 per cent. instead of 6, which was the rate upon their preference capital. He might mention a few facts showing the steady progress the business of the company was making at all their centres. In Bristol, exclusive of private line renters, they had more than 500 subscribers; in Plymouth, 300; Portsmouth and Bournemouth, 200; and Torquay, Cardiff, and Swansea were fast drawing on towards 200 each. Quite lately they had opened an exchange at Southampton connecting with Portsmouth. The trunk system had been extended in South Wales and other parts of the district, and they hoped in a few weeks' time to have Plymouth connected with Tavistock in one direction and Torquay in another. Bournemouth would be connected with Winchester, Southampton, and Portsmouth; and, coming nearer home, Bristol and Gloucester would be connected with Cheltenham. All these works were in a very forward state. There were other extensions contemplated, one of the most important of which was the connection of Bristol with Birmingham. The trunk to London, he hoped, would very shortly be proceeded with. The general arrangements might be said to have been agreed to between their company and the United Telephone Company, and they might look forward to London being connected before the end of the year with Bristol, and consequently with Gloucester and South Wales. If it were determined to approach London from the South, rather than by way of Swindon, it would also complete the communication between London and Bournemouth, Southampton, and neighbouring places. As showing the increased use made of the telephone, he might mention that the number of messages sent over the trunks in November, 1887, was 6,945, while in November, 1888, it was 14,675—the number having more than doubled in the year. The directors had lately issued a notice proposing to give subscribers the free use of the local call office for local calls, on the production of a pass, which might be obtained at the company's offices. He hoped this would have the effect of further popularising the telephone. Adverting to the great advantage of the telephone to country medical practitioners, he read a letter from Mr. Alfred H. Twining, of Salcombe, stating that his partner and himself had connected their houses, which were five miles distant, with the telephone with the most satisfactory results. In conclusion, the Chairman said he felt he might congratulate the shareholders upon the satisfactory condition of the business of the company, and added, in reference to the resolution he had proposed, that although they were empowered by the articles of association to raise money at 6 per cent., they had not the slightest idea of paying more than 5 per cent. for the debentures that were now to be issued.

Mr. Mark Whitwill seconded the resolution, remarking that the money was being raised in order to extend the business of the company.

Mr. Richard Cory, supporting the resolution, said he had no doubt when the advantages of telephonic communication over telegraphy became more widely known their business would be quadrupled, especially in South Wales.

The resolution was carried. and the meeting concluded.

The Eastern Telegraph Company, Limited.

THE report for the half-year ended 30th September, 1888, states that the revenue for the period amounted to £310,104 15s. 8d., from which are deducted £83,332 3s. for the ordinary expenses, and £43,075 8s. 8d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,226 15s. 7d. for income-tax, there remains a balance of £179,470 8s. 5d., to which is added £884 8s. 9d., brought from the preceding half-year, making a total available balance of £180,354 17s. 2d. From this balance there have been paid—

	£	s.	d.
Interest on debentures and debenture stock	28,264	12	4
Dividend on preference shares ...	20,474	3	10
Two interim dividends of 1¼ per cent. each on ordinary shares	95,000	0	0
	£143,738	16	2

leaving a balance of £36,616 1s., which is carried forward to the next account.

The revenue includes £25,791 15s. 11d. dividend for the half-year upon the company's shares in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph companies. The cables of these companies are in good working order. Details are given in Abstract C of the repairs and renewals of the cables, the several sections of which are now in good working order, with the exception of the Aden-Bombay original cable, which is under repair.

The directors have entered into a new convention with the French Government for the special wire through France, in connection with the company's cables at Marseilles, and the prolonged negotiations on this subject are thus satisfactorily concluded.

In accordance with the special resolutions passed at the extraordinary general meeting held on November 22nd last, the 20,000 new ordinary shares have been issued and taken up by the shareholders at £12 per share.

The new cables for the West Coast lines of the Eastern and South African Company, which are to be worked by this company, are in course of manufacture by the Telegraph Construction and Maintenance Company, and the India-rubber, Gutta-percha, and Telegraph Works Company, and will be laid, according to contract, during the spring.

The directors regret to announce the death, in August last, of Lord Alfred Paget. The vacancy thus occasioned on the board has been filled up by the election of Sir Albert J. Leppoc Cappel, K.C.I.E., late Director-General of Telegraphs in India.

The Direct United States Cable Company, Limited.—The board has resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum for the quarter ending December 31st, 1888, such dividend to be payable on and after the 26th instant.

Globe Telegraph and Trust Company, Limited.—A dividend of 1s. 3d. per share is announced for the past quarter.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 11th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,248.

AMERICAN NOTES.

By DAS TELEPHON.

THERE is now in process of promotion by an electric light syndicate, a big stock company to control the business of electric lighting in the United States; this scheme comprehends, first, the control of the Edison system with the parent and branch companies scattered through the cities of the United States, and second, the consolidation of the leading opposition organisation using the incandescent light in the way of central stations for the distribution of electricity for light and power.

The Edison system has licensed 150 central stations in the United States, with an aggregate capital of $30,000,000.

The Westinghouse Electric Company, which uses the alternating current plan, and is the chief competitor of the Edison, has established 13[illegible] central stations, with a capital of about $10,000,000. It would therefore require upward of $40,000,000 to control and consolidate these two systems and to make the extensions deemed to be necessary to the placing of the combination upon a foundation so strong as to be practically beyond competition. The dozen smaller incandescent companies could be swept into this great "combine" just as soon as the Behemoth could open its capacious jaws. There would be no difficulty with the little fellows.

Forty millions of dollars is a big sum to put into a single enterprise, but it looks as if it would be done if the electric light syndicate succeeds in gaining control of the business on the basis which is now contemplated. It is rumoured that when the big syndicate has swept the country, a company will be formed with $40,000,000 in cash and bonds, and $40,000,000 in good *ordinary everyday water*. Then the favoured gentleman on the ground floor will be invited in to partake of the feast when the great water-melon is cut.

How many millions are already invested nobody knows but the syndicate people, and they won't tell.

On December 21st, awards were made for electric lighting of the streets of Philadelphia. As all the arc lights companies are in a syndicate there was no competition. Each company takes a certain territory, and no one else puts in a bid for that part of the city. The average cost of electric lighting next year will be about 47½ cents per lamp. The highest price—55 cents per lamp—is paid in the rural districts, and the lowest—45 cents—in the central part of the city. The awards are: to the German Town Electric Light Company, 2,000 candle-power lamps, at 55 cents. Frankford, 55 cents; Northern Electric Light Company, 1,200 candles, 48 cents, Brush, 2,000 candle-power, 47½ and 48 cents; United States Electric Light Company, 2,000 candle-power, 49 cents; Philadelphia Company, 2,000 candle-power, 45 and 47½ cents; Wissahicken Company, 700 to 800 candle-power, 55 cents. The amount appropriated for electric lighting is $130,000. Under the contracts the lights must burn from sunset to sunrise. Lights burning less than nine hours from September 1st to March 31st, or less than six hours from April 1st to August 31st, will not be paid for. Failure of the lights for two nights will terminate the contracts.

Type Setting Machines.—The effort for a mechanical contrivance to do away with manual labour has taken a long stride in the newspaper world. A machine that will set type has been the goal of many years, and it seems to have been reached. The *New York Tribune* may now be said to be set up by machinery. There are some 20 machines at work in the office, and, with the exception of some tabular and other special work, they get out the large ten-page paper usually issued every day. Each machine requires a man to run it, and turns out with mechanical accuracy about 4,000 ems of composition an hour, or about the average work of four men. The machines prove conclusively that the type can be set up by mechanical process, but whether it is a more economical way than that in vogue since Caxton's time has not yet been sufficiently demonstrated.

The old printers are sceptical, but the young generation, with the wonders of the telephone, the typewriter, and the phonograph before them, are sure that there is soon to be a very radical change in the methods, as there has been in the results, of the art preservative.

Millionaire Mackay Gets a Present.—There is on exhibition in a Broadway window a piece of silver plate representing, on a globe, the Commercial Cable Company's system in a chaste design for a centre piece. It is a Christmas present from the officers and staff of the company to its president, Mr. J. W. Mackay, to commemorate the fourth anniversary of the opening of its cables to the public, and as an expression of their esteem for him. This will be accompanied by an illuminated album containing an address and the signatures of every member of the staff, both in the United States and in Europe.

The *employés* of the Commercial Cable Company on both sides of the Atlantic were informed yesterday that a Christmas present of half a month's salary had been made them by John W. Mackay, the president of the company.

This is the fourth Christmas at which Mr. Mackay has remembered his cable staff, numbering some 270 people, in a similar manner.

From the telegraph desk to the bench. Governor Scales, of North Carolina, has appointed Mr. George Brown, jun., Judge of the first judicial circuit, to succeed Judge James E. Shepherd, who was chosen one of the Judges of the Supreme Court of the State at the November election. Judge Brown is about 40 years of age, and was afforded but ordinary opportunities for an education. After the war he went into a telegraph office, and soon became an expert operator. He was finally made chief of the operating force in the principal office of the Western Union office in New York. Whilst thus engaged he read law, and, graduating, returned to Washington, N.C., where he commenced the practice of his profession, and met with immediate and profound success. Judge Shepherd was also a telegraph operator.

Anent "the West India and Panama Cable Company," and the conflict between it and the new French Cable Company, I send you the following letter, which has been addressed by the manager of the French company to the New York Chamber of Commerce, with the request that it be laid before Congress. The letter records:—

"As you learned in New York, it is the Spanish authorities who have for the last eight months delayed the opening of our cable, but this step was provoked and is maintained by the West India and Panama Telegraph Company, which, under the protest that they possess the monopoly of landing cables in Cuba, have made protestation against our company.

"We hold a concession in perfect order.

"The English protestation has been sent to Madrid, and there is not a shadow of a doubt that the decision will be in our favour. But, meanwhile, we are subjected to all kinds of the most pettifogging vexations on the part of the English companies.

"The protestation of the West India and Panama Telegraph Company rests on absolutely nothing at all, a fact well known to that company; but their board does not stick at such trifles as truth and self-respect. Their aim is to delay the opening of our cables, so as to make us lose our concessions, and in their eyes any means to that end are good.

"I am told that the West India and Panama Telegraph Company in their action against us have the support of the Cuba Company, International Ocean Telegraph Company, and the Western Union.. I do not believe it; but, if true, it must be under some false representations.

"UNIVERSAL FEELING OF INDIGNATION.

"We compete with nobody, and we complete the network of telegraph in the West Indies. Our lines will come in as feeders and a source of revenue for all the existing cables. The traffic will soon exceed that of the West India Company, and to reach the United States and Europe we pass over the Cuba, International Ocean, and Western Union lines. Already, notwithstanding impediments and difficulties, I have sent over fifteen thousand words and paid them a sum reaching $10,000. It would be five times as much had our traffic been accepted in a business-like way.

"If the opposition continues we shall be compelled to lay an independent cable, but I cannot see why the American companies should drive us to that extremity, as they will lose our traffic, and bring about a war tariff.

"The West India Company, whatever they may say, are interested in our laying a cable to the North, giving them a duplicate way for the exit of ther traffic, and consequently lower rates on connecting lines.

"If the Western Union, instead of being lead by the West India Company, can afford five minutes time to consider the matter, they will certainly come to my conclusion.

"Such a huge concern as the Western Union can afford to discard such a traffic as ours, whatever it may be; but I hope that the interest of United States commerce will be sufficient for them to announce the opening of our lines, and accept telegrams for our stations.

"The foreign commerce of Venezuela has quadrupled within the last few years, through the development of the country's vast agricultural and mineral resources, and statistics show that the West India governments and commerce are highly interested in having a cable communication with that growing country.

"The conduct of the West India and Panama Telegraph Company is raising a universal feeling of indignation among its shareholders, as they have never paid a dividend. The customers are also enraged. . . . If the Northern companies continue to humour the West India Company, the cable from Jamaica to Halifax will soon be laid, and then it will be easier for us to pass our traffic."

"So you and Herbert are going to be married?" said one young woman to another.

"Yes, during the holidays."

"You didn't threaten him with a breach of promise suit, did you?"

"No. I merely showed him the *phonograph* that I always keep concealed under the sofa."—*Merchant Traveller*.

New York sheriff (to condemned murderer)—"Here is a chair. Say your prayers and take a seat in it. The *electrician* is ready."

Prisoner—"Eh? Won't there be no procession—no parade?"

"None."

"No walkin' with firm step up the gallows?"

"None."

"No big crowd an' chance for me to make a speech and die game?"

"No. You die right here."

"My! My! Oh, my! I—I wish I hadn't done it."—*Philadelphia Record*.

Washington, *December 28th*.

Those of the readers of the REVIEW who are interested pecuniarily in that great Behemoth, the Western Union Telegraph Company, need have no fears as to their investments in that company on perusing the following legal announcements. On

December 31st the Sheriff of Philadelphia received a writ of *quo warranto*, commanding him to summon the Western Union and Baltimore and Ohio Telegraph Companies before the Dauphin County Court to answer for an alleged violation of the Constitution and the laws of the State. The writ, which is returnable on January 29th, was served by a sheriff's deputy on the principal officers of the company stationed at the main office, at Broad and South Peen Square. The paper filed by the Attorney-General, which forms the basis of the suit, sets forth that the Western Union Company on October 5th, 1887, in violation of the constitution of Pennsylvania, purchased the entire stock, and thereby a controlling interest of the Baltimore and Ohio Telegraph Company, and still holds the same—38,750 shares of the capital stock of the par value of $3,875,000, and paid therefor $5,000,000; that the Baltimore and Ohio Company was a competing line in this State with the Western Union, and that its stock, line and franchises were by reason of the sale forfeited to the State.

For the same reason the Attorney-General claims a decree of forfeiture and escheat of the line, property and franchises of the Western Union Company in this State. The Attorney-General claims a forfeiture of the line, franchises and property of the Baltimore and Ohio Telegraph Company of Pennsylvania because of such purchase and consolidation.

The recent triumph of the Garrett interest in the election of the new Baltimore and Ohio president is believed by many to account for the suit, but it is stated on authority that the Attorney-General has taken the step of his own free will, and would have moved in the matter over a year ago had he been in possession of positive proof.

No doubt the defendants will make a legal return to this formidable writ, but the actual return will be somewhat as follows: "What if we did—you cannot prove it, and if you do prove it, what are you going to do about it? Our immense wealth and the thousands of free telegraph tickets in the hands of judges, lawyers, legislators and jurors are our guarantee against all such impudent attempts to rob our coffers."

The law requiring capital punishment to be effected by means of electricity in the State of New York went into effect on the 1st day of this year. The following are its provisions:—"The judge sets two days a week apart, within which the murderer must be executed; a judge of the Supreme Court, the district attorney, the sheriff, two physicians, twelve reputable citizens, two clergymen, and seven deputy sheriffs may be present. The body must be buried in the prison graveyard, and consumed by quicklime. No religious exercises will be permitted over the body. The newspapers are forbidden by law to publish any account of the execution, beyond the statement of the fact that it took place."

The first death penalty by means of electricity will take place on 9th inst. in New York City. The following form of sentences has been suggested as possessing the practical value of being terse, scientific, and to the point:—"I therefore sentence you to be taken to Sing Sing Prison, there to remain confined until the day of ——, 188—, between the hours of —— and —— a.m., when you will be taken to a cell specially designed for that purpose, be forcibly seated in a properly insulated chair, with one rheophore placed upon the junction of your frontal and parietal sutures, and the other just over your medulla oblongata, and then and there made conductor for an alternating current of 18,000 volts intensity from a dynamo constructed for that specific purpose, said current to pass through the ganglia and vasomotor centres of your cerebal tissue until you are dead, dead, dead, and may the Lord have mercy on what is left of you."

Once more the Chicago Stetho-telephone man comes to the front. I saw this instrument several years ago in process of being constructed in New York, under the superintendence of the inventor, by whose invitation I was present at several tests as to its operativeness. Long sentences were reproduced with clearness of tone and distinct articulation.

The transmitter is simply a microphone consisting of carbon bars suspended at the top, with their lower part resting against a carbon bar, which is attached to a thin vibratory board, from which board projects a thin tube of wood or other hard substance; a small button protrudes from the end of the tube, which acts like the ordinary electric bell push.

This button is placed against the throat near the vocal chords; the magnet receiver is held as usual against the ear. When the operator speaks, the vibrations of the throat are communicated to the board to which the microphone is attached—*so said the inventor*. To my mind it was evident that the air waves produced by speaking acted on the microphone as in the usual way, and that the speech reproduced was caused by such action of the air waves, and not by the vibrations of the throat; at the same time it may be that these vibrations of the throat reproduced the words.

[Probably the Lowth telephone is that to which our correspondent refers.—EDS. ELEC. REV.]

THE WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY, LIMITED.

THE company has during the year 1888 opened new exchanges at the following places:—Pontypool, Tredegar, Plympton, Worcester, Totnes, Winchester, Cheltenham. The progress of the company's exchange and private line business is shown by the following:—On December 31st, 1887, the company had exchanges at Aberdare, Bath, Bournemouth, Bristol, Cardiff, Clifton, Devonport, Exeter, Gloucester, Jersey, Landore, Llanelly, Mutley, Merthyr, Newport, Neath, Newton Abbot, Paignton, Plymouth, Poole, Pontypridd, Southampton, Swansea, Shrewsbury, Torquay, Weymouth, with 1,572 exchange subscribers and trunk renters, and 462 private lines, a total of 2,034. The company now has 2,054 exchange subscribers and 556 private lines, a total of 2,610.

In addition to the foregoing, the company expects to shortly open exchanges at Salisbury, Stroud, Tavistock, Truro, Fareham, Gosport, Dartmouth, and Brixham.

The following additions to trunk lines have been made during 1888, besides running extra wires on previously existing trunks between Bristol and Cardiff, Cardiff and Swansea, Bristol and Bath, and Bristol and Gloucester, to accommodate the increased traffic:—Bristol with Portishead, Newport with Pontypool, Cardiff with Tredegar, Tredegar with Pontypool, Gloucester with Cheltenham, Plymouth with Plympton, and Torquay with Totness, and the company has how the following lines connecting towns open and working:—

			Distance.	
Bristol	to	Avonmouth	8¼	miles
„	„	Portishead.	11	„
„	„	Bath ...	13¼	„
„	„	Gloucester	39	„
„	„	Cheltenham	49	„
„	„	Newport ...	52¼	„
„	„	Cardiff ...	66¼	„
„	„	Pontypridd	78¼	„
„	„	Swansea	116¼	„
„	„	Llanelly	128¼	„

	Distance.	
Swansea to Morriston, Neath, and Briton Ferry	17	miles.
Newport to Pontypool	10	„
Pontypridd to Aberdare and Merthyr..	16	„
Merthyr to Pontypool	22	„
Bournemouth to Poole	6	„
Torquay to Paignton..	3	„
Paignton to Totnes ...	6	„
Plymouth to Plympton	5	„

The extent of this work of connecting towns together in the company's district throughout the West of England and South Wales may be gathered by stating that the company has now 266 miles of poles or route for this branch of their business, with 1,355 miles of wire; but the company is making further trunk extensions, notably the following:—Cardiff to Barry Docks, Plymouth to Tavistock, Plymouth to Torquay, Bournemouth to Southampton, Winchester, Fareham, Gosport and Portsmouth, and Torquay to Dartmouth. The number of poles required for the trunks completed and on hand is over 10,000.

The average number of calls on the company's trunk lines is now 15,000 a month. Subscribers and the public (the latter from telephone call rooms) have the use of the trunks on payment of a toll per message, 6d., 9d., or 1s., according to distance, a period of not more than three minutes duration being allowed for each communication.

At the end of the year 1887, the company had 50 call rooms open; but during the year 1888, further rooms have been opened for the use of subscribers and the public, and at this date there are 75 public telephone call rooms throughout the company's district. As an additional facility to subscribers, it is intended to give them the free use of these call rooms for local calls in their own town, upon production of a pass to be supplied by the company.

During the year ending December, 1888, the total number of calls through the exchanges and trunk lines of the company was 1,937,000, and as each call necessitated a reply, the total number of communications over the lines during the past year was 3,874,000.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

AN ordinary general meeting of the former Society of Telegraph-Engineers and Electricians under its new title of the Institution of Electrical Engineers was held on the 10th inst., Mr. **EDWARD GRAVES**, president in the chair.

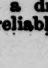
The **SECRETARY** read a letter from Prof. Silvanus Thompson declining the premium which had been awarded him by the society, and stating that while he fully appreciated the honour of the award he considered that such premiums were for younger members.

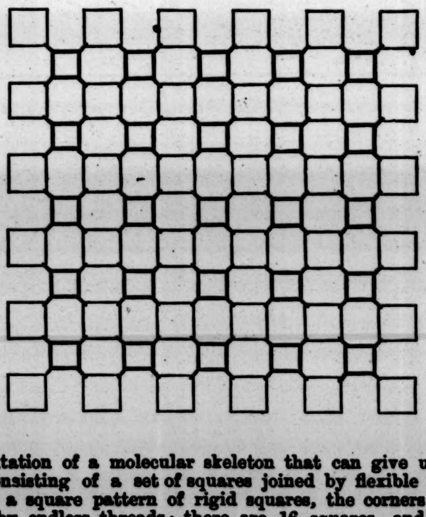
Mr. E. **GRAVES** then introduced the President for the year, Sir **WILLIAM THOMSON**, F.R.S.S., D.C.L., &c., who delivered his

INAUGURAL ADDRESS.

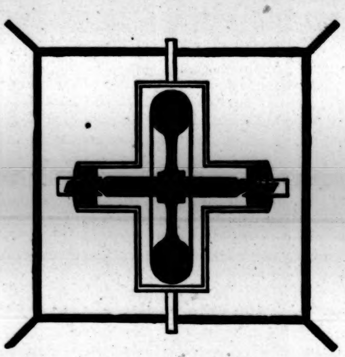
Gentlemen,—I beg to offer you my warmest thanks for the honour you have done me in electing me to be the first president of the Institution of Electrical Engineers. Fourteen years ago, when the then three-year old Society of Telegraph-Engineers honoured me by appointing me to be their president the society numbered 570 members; it now numbers 1,550. It is gratifying to us to think how successful that young society has been, and how much it has grown. But while we think with pleasure of the great increase of our numbers, that pleasure is saddened by the thought of how many of the old members are gone, and especially the first two presidents, Sir W. Siemens and Mr. Frank Scudamore. The genial presence of Sir W. Siemens is a happy recollection to many of us, I think I might say to nearly all present, and the thought that he will be no more with us is certainly a very great grief to all who have known him—a loss to science and to England. We look back upon Mr. Scudamore's presidency with great satisfaction considering all that he did for the society, and his loss is deeply felt. Three of the Presidents since I had the honour to serve are also gone—Mr. C. V. Walker, Colonel Bateman Champain, and, within the past year, Sir Charles Bright. The first Atlantic cable of 1857 gave me the happiness and privilege of my first acquaintance with Sir W. Siemens. In the course of that work Sir Charles Bright was my colleague; he was engineer to the company, and I made his acquaintance during the 33 days when we were out of sight of land in the ever memorable *Agamemnon* expedition of 1858. Sir Charles Bright was full of vigour and enthusiasm, and to his vigour, earnestness and enthusiasm, in a great measure, was due the existence of the temporarily successful cable of 1858, and of the great consequences which followed from it, even though that cable itself had a very short life, having only three months of working time and a still shorter term of really practical useful work. Still we must always look upon Sir C. Bright as a pioneer in the great work when other engineers would not look at it and who thought it was absolutely impracticable; we must always look back upon our late colleague, lost within the last year, as having done much indeed for the Society of Telegraph Engineers. The Society of Telegraph Engineers has grown not only in membership but in the extent of its province from the time of its foundation until now. It became the Society of Telegraph Engineers and Electricians a few years ago, and now the more appropriately representative title of the Institution of Electrical Engineers has been adopted. The original name included only telegraphy, but that was not then the only application of electricity to engineering; there then was electro-metallurgy. Telegraphy and electro-metallurgy were, I think, the only two branches of practical science to which electricity had then been applied, but since that time we have had a vast augmentation of the field. We now have telephony, electric transmission of power—the Society may well recollect Sir William Siemens's introduction of the great subject of the electric transmissson of power on a scale of practical usefulness. I think we may safely feel that the Society of Telegraph Engineers in a large measure is due to that practical development of electricity—we have now electric haulage, electric tramcars, and many other fields: we have the application of electricity to naval and military purposes, and, last but not least, we have the application of electricity to electric lighting. With all these grand subjects of applied practical science for our province I think the Institution of Electrical Engineers may feel that it has a great and a noble dominion. I find it difficult to remember the new title, but I am proud of it, as I am proud of being its President; and I would mention our allied Society, the Institution of Civil Engineers, and remark that the province of the electrical engineer necessarily touches upon that of the civil engineer. When, 14 years ago, I gave my inaugural address, I endeavoured to impress upon engineers and architects that architects made a great mistake in not being engineers, and in not qualifying themselves as engineers, and doing the work of engineers; that architects did not do their duty to their clients in not being engineers and understanding the engineering of their own works and making engineering science, particularly the dynamics of engineering, an essential part of the training of an architect. It is not necessary to make any animadversion on electrical engineers. I think in this respect electrical engineers know well that they must, before all, be engineers; they must be engineers, and they must learn engineering. Young persons who have a taste for electrical machines—and who that is young has not a taste for electrical machines, spark flashes, the artificial aurora borealis and phosphorescent effects with the influence machine?—think they would like to be electrical engineers, and they think that electrical engineering is all ether and electricity. Now I have continually to impress upon many anxious parents that their boys must condescend to learn something of gross ponderable matter; that electrical engineering is not all electricity and ether, but that ponderable matter is also part of the subject. The youthful aspirant to the honourable profession of electrical engineering ought to learn mathematics and dynamics; after having the elements of a good general education, he ought to learn mathematics and dynamics well, then a good deal of chemistry and regular mechanical and civil engineering, besides electricity. It may be said that juvenile life is too short; I do not think it is. I think if the other subjects are well learnt, electricity may be learnt in a few months. I am perfectly sure that if a youth is qualified in other departments, the mere addition of electricity to the education of a competent engineer will not take so very long a time, and that the merely educational part of the work will not be protracted unduly by adding electricity to the branches learned in general engineering. I do not mean to say that if electrical engineering is the branch adopted there is not a prodigious and endless field in which the worker will learn every day of his life, though he lives more years than any person present. I wish just to make these few remarks in the beginning, because they do seem to me of some practical importance, and worthy of being put in the front of the address I have to offer as the first President of the Institution of Electrical Engineers. And now these remarks have suggested to me a subject for the scientific exposition that I might give you in this evening's address, that is ether, electricity, and ponderable matter. The demand for something like a mechanical explanation of electrical phenomena is not new, but it is growing in intensity every year. The proceedings of recent meetings of the British Association, and especially of the last meeting of the British Association, illustrate the growing desire to know something below the surface, to know something of the internal relations connected with the wonderful manifestations of force and energy which are put before us in the case of a magnet in the working of an electrical machine. The addresses of past presidents of the parent Societies of Telegraph-Engineers and Telegraph-Engineers and Electricians illustrate also the growing desire to know something of the molecular theory or atomical theory of electricity and magnetism. Mr. Preece in his address pointed out how Maxwell had shown the velocity of light to be related to electricity in such a way that we can scarcely doubt but that the propagation of electromagnetic disturbances through space, which we have every reason to believe does exist, which, in fact, from known laws we may say certainly does exist, we may believe it to be propagated with a velocity equal to that of light, that the propagation of electrical disturbance and of light may perhaps be identities. Mr. Preece alluded to the disturbance of the sun's surface and simultaneous magnetic disturbances which had been observed in his telegraphs and other operations of an electromagnetic character on the surface of the earth. Many presidential addresses have opened the ground of the keen desire for an electromagnetic theory. Mr. Preece's address was in 1880; in 1883, if I remember right, Mr. Willoughby Smith alluded to some experiments which I considered to be very beautiful and instructive, which he was making, and to which he only gave a very slight reference in his address, illustrating the screening effects of different kinds of metal upon electromagnetic and electrostatic inductions. Electric inductions simply, we may say, because we began to feel the distinction between electrostatic inductions and electromagnetic inductions. In his subsequent work Mr. Willoughby Smith gave an exceedingly beautiful and interesting illustration of the screening effect of lead, copper, and iron, of which a slight sketch was given in his presidential address. A little earlier the subject was mathematically worked out with great power, but perhaps most notably by Horace Lamb. I feel it almost invidious to mention names, there are so many workers who touched upon the same subject. Nivin and Lamb went simultaneously over very much the same kind of lines, Nivin being a date earlier in the way of communication and later in the way of publication in the transactions of the Royal Society. There may be some difference with these two writers in point of priority, but I mention Lamb's name because the screening is more particularly developed in his mathematical paper. In the memorable presidential address of Prof. Hughes another allied branch of electro-magnetic induction was very admirably illustrated by experiments which are now more or less familiar to us all, but which are of themselves of an immensely suggestive and stimulating character, both to mathematicians and to experimental workers. The very criticisms by mathematicians upon some of the expressions and modes of statement by Prof. Hughes have, with Prof. Hughes's own statements, given a stimulus and suggested mathematical and experimental scrutiny that might have been wanting for many a year.

One of the earliest problems in which electrical induction had to be considered was that of submarine telegraphy. The subject of induction in telegraph wires presented itself in a peculiarly perplexing way to the first workers in that department. There was the general knowledge of electro-magnetic induction between two wires, which had been worked out by Henry and Faraday in a very full manner; that was the only kind of induction which was thought of by some of the pioneers of submarine telegraphy. Another kind of induction more thought of by others was the electrostatic induction due to the Leyden jar charge of the insulated wire. Faraday, in this department, as in the other department, was the origin of nearly all that we now know. Faraday explained in a very beautiful and clear way the electrostatic charge of a submarine cable, and, without going into the details, he showed that the conduction of a current through the cable required the wire, as we should now more learnedly and more clearly express it, to be raised to the difference of potential from the earth required to cause the signal current to pass through it. Cromwell Varley made very important advances in that direction. At the meeting of the British Association in 1854, in Liverpool, he brought forward some important developments of Faraday's doctrine. Then came on the great Atlantic Cable question, and I always remember how that question came upon me. Prof. Stokes's presence is a reminder of the circumstance. I was hurriedly leaving the meeting of the British Association when the son of Sir William Hamilton, of Dublin, was introduced with an electrical question. I was obliged to run away to get a steamer by which I was bound to leave for Glasgow, and I introduced him to Prof. Stokes, who took up the subject in the method which is inevitable with him. He wrote me, and some correspondence passed between us, and the result was that a little mathematical theory was worked out which constituted in fact the basis of the theory of working submarine cables. In that theory electromagnetic induction was not taken into account at all. Leaving it out of account was justified by the extent of signalling which the circumstances of a cable extending 200 or 300 miles in length dictated. For a cable of more than 200 or 300 miles the speed of working was essentially limited by these electrical considerations, limited so much that the electromagnetic induction certainly could have no sensible effect: but the possible speed of working in a cable of 20 miles, 50 miles, or even 100 miles was so great that in short lengths like those the electromagnetic induction still came into play. I worked out the subject partially myself. I found it necessary to do so to satisfy myself that the doctrine upon which the Atlantic cable project, then growing up, and upon which it was ultimately founded, was thoroughly trustworthy. I found it necessary to investigate the question of electromagnetic induction. This question was farther forced upon me by communications that I had with my friends, the two brothers, Charles William Siemens and Werner Siemens, with reference to the Mediterranean cables. It was imagined that electromagnetic induction alone was the obstacle, and that the embarrassment in working through a submarine cable was due to electromagnetic induction alone. On going into the subject fully it became demonstrated that electromagnetic induction would have no sensible effect in the proposed Mediterranean cables, and thus the proposal to put two thin wires close together, in order to obviate electromagnetic induction was given up. Experiments in Germany had shown considerable electromagnetic induction on short lengths of cable, and that embarassment, or whatever it may be called, was diminished by using wires very close together. It was shown that the diminution of electromagnetic inductive influence would produce a corresponding increase in the electrostatic inductive influence; and when it was pointed out that the electromagnetic inductive influence would be absolutely insensible at the highest speed of working the proposed cables, the idea of making them of twin wires close together for metallic circuits was given up, and the present type of cable was adopted. But now it is very interesting to us to find that old question revived. I myself laid it aside; it was in a corner of my mind, and in some corners of my note-books for some few years, and within the last forty days I have really worked it out to the uttermost; really for my own satisfaction. But in the meantime it has been worked out in a very admirable and complete manner by Mr. Oliver Heaviside, and he has pointed out and accentuated the result of his mathematical theory that electro-magnetic induction is a positive benefit; it helps the current, it is the same kind of benefit that mass is to a body shoved along against a viscous resistance. Suppose, for example, we had a railway carriage being moved, where there had been an inundation, through a quantity of mud or other matter which obstructed its progress; or take a boat on wheels—we cannot take a boat in a fluid on account of the gravity; but suppose two boats of the same shape in a viscous fluid, one of them being ten times the mass of the other; if they are shoved off with a certain velocity, the boat of greater mass will take greater force to give it its impulse, but it will go further. That is Mr. Oliver Heaviside's doctrine of electromagnetic induction; it requires more electric force to produce a certain amount of current, but the current goes further. My example is a very crude way of putting it, and does not do justice to Mr. Heaviside; but the whole thing is worked out in a most complete simple way, and the fact that the effect of electromagnetic and electrostatic induction taken together—they cannot be separated—is fully worked out. One thing that was known of old is made the subject of Mr. Heaviside's treatment of the cable proper, that is, the beneficial effect of leakage in clearness of signals. All telegraphists remember that two or three leaks in a cable, if they would remain constant and not introduce the extra trouble of earth currents, make the signals come out more distinctly; that used to be known, and the general reason was pretty well known and pointed out by mathematicians. Now Mr. Oliver Heaviside has taken that subject, and included it in his work. He has included induction of this kind along with electro-magnetic induction; he has particularly accentuated it, and it is a practical point of importance that the question of clearness of signals is not simply, or even very importantly, how much is the current attenuated at the remote end of the cable, how much is the amplitude of the electric current (or of the variation of the electric potential in another mode of working) attenuated in transmission through a thousand miles or two thousand miles of cable. A certain range is given at the sending end; what is the range at the receiving end? That is an important question, but it is not the most important question with reference to the clearness of signalling, in fact we might almost say it is not an important question at all, because there are certain restrictions and limitations as to speed with which submarine cables can be worked in respect to high potential. Setting that idea aside, on the one hand, and considering the practical sensibility of the instruments, on the other side, we have a large margin, even in submarine cables, for increasing the working power on the one hand and increasing the sensibility of the instruments on the other. It is not the smallness of the signals at the receiving end that is the real difficulty in a submarine cable just now at all, it is the running of one signal into another, it is the want of correspondingly definite features between a single signal, or a group of two or three signals at the receiving end and at the sending end. There are two things to be considered in respect to the distortion, as Mr. Heaviside has called it, of the signals in passing through a cable—one thing is the retardation of phase, another is the diminution of amplitude. If the retardation of phase was the same for periodic currents, alternating currents of all periods, then the retardation phase would be of no consequence whatever, it would not impede the distinctness at all. Again, if the diminution of amplitude was precisely in the same proportion for alternating currents of all periods, then when we came to make up the signals we should find that the signals would be transmitted with perfect sharpness. In fact, if we compare the transmission of electric signals through a wire, with the transmission of sound through air, we have in the case of transmission of sound through air great attenuation by distance, inversely as the square of the distance, in fact, but the same for all notes. Again, retardation of phase depends upon the velocity of sound. the same for all notes, the result is that speaking, musical performances, and signals of all kinds in air, lose none of their clearness by distance. It is just a question whether the very greatest distance at which a sound can be heard is due to any want of clearness due to different attenuations of the different notes, or the different elements forming the compound sound, or difference of retardation of phase. I must not keep you too long on this subject, but it is one of much practical importance. Mr. Oliver Heaviside considers that electromagnetic induction causes a less great difference in the attenuation of different periods than there is without it, and that electromagnetic induction, as we knew 40 years ago, tends to reduce the retardation phase to the same for all different notes, and, in short, the phase of electric signals is retarded exactly as much as the phase of luminous vapours is retarded if the signals have but sufficient frequency for the circumstances. It was known to the earliest workers in the subject, and Kirchoff pointed out that it was approximate to the velocity of light, and Maxwell arrived at a probable explanation of electrical effects by the influence of a medium, showing that the medium must be ether, the medium to whose motion light is due. Maxwell's electro-magnetic theory of light marks a stage of enormous importance in the electromagnetic doctrine, and I cannot doubt that in electro-magnetic practice we shall derive great benefit from the comparison of electrical effects line by line, following Heaviside's theory of dealing with submarine cables, and showing how greater clearness is obtained as that condition is approached. The comparison with light and sound is just one instance of how the highest mathematical power of working and judgment, as to physical applications, helps on the deep and profound theory and drags it into a practical channel. The telephone, one of the added subjects of the Society of which we are members, illustrates very splendidly these developments of the theory of the transmission of signals through a submarine cable. The telephone signals have, in fact, sufficient frequency to make electromagnetic induction very sensibly influential, the frequencies corresponding from 250 periods per second up to 200, 300, or 400 times that which are the frequencies involved in speaking. The human voice, tenor and soprano, and the quality of the voice as affected by the overtones, also periods of frequencies of from 256 periods per second to 1,000, or 1,500 frequencies per second, are concerned in the fundamental notes and in the characterising overtones of the sounds transmitted by the telephone. There seems no doubt that the clearness of the telephone is to a large degree due to the circumstances that Mr. Heaviside has pointed out, that we have much less difference of attenuation for different notes, and that the frequencies of the notes in a telephone were independent of the practical dimensions of the telephone wire. I can scarcely speak on this subject without just touching upon a question which I do not propose to enter fully upon to-night, that is the efficacy of iron and copper as telephonic conductors. The information given to me by Mr. Bennett, the engineer of the National Telephone Company in Scotland, leaves no doubt whatever but that there is very considerably less of clearness in speaking through an iron wire, such, for instance, as the first metallic circuit iron wire of the Post Office between Glasgow and Edinburgh, than there is in speaking through a copper wire of the same resistance. I shall say no more of this just now; it is an exceedingly difficult and complicated subject, but with Mr. Heaviside's investigations, and with Lord Rayleigh's special investigations on the susceptibility of iron to very small differences of magnetic forces, differences of magnetic forces superimposed on even powerful magnetic forces, or a large residual magnetism, the matter is in a very hopeful condition. The subject is in good hands, mathematical and practical, and I think before many months pass of the existence of the Institution of Electrical Engineers, we may have an absolutely clear understanding of telephony through iron wires compared with telephony through copper wires. I intended to put a few figures on the board, but, unfortunately, they were left in a hansom cab, and I can only quote from memory. I made calculations for the problem of alternate currents through copper wire. I have not applied it to iron wire yet, but for either telephone wire or electric light wire with alternate currents, I worked it out in Bessel's functions; every mathematician knows how to do it. It is an extension of Bessel's functions, a problem of periodic variations at one end of an infinitely long copper wire, or differences of potential between two parallel copper wires, or a copper wire and a copper tube surrounding it for return; we may vary the thing about very much, according to circumstances. But, after all, one of the very simplest things is this, two parallel copper wires, if the distance between them is a large multiple of the diameter of each, as is the case in practical telegraphy and telephony, the problem is as easy as the problem of a single copper wire in the centre of a cylindrical tube of copper. Well, now, as Mr. Heaviside remarked, and as everyone who has worked out the subject must have known, the distribution of currents within a copper conductor is quite independent of the surroundings, provided only they be symmetrical all round, or provided they be that of two parallel wires, where the distance between the two wires is a large multiple of the diameter of each, and where the current in each is not sensibly influenced by that in the other by being arranged in concentric cylindrical areas of equal current density. Well, now the distribution depends simply on the frequency, not at all on the surrounding circumstances. While speaking on such an abstruse subject as electricity, ether and ponderable matter, I wish just to give one little piece of practical information to some, though it may not be to all. The table I have prepared will, I hope, appear complete in the report of this address, but in the meanwhile I will try and give one or two of the numbers which are rather interesting. Take 80 periods per second as the frequency, that is about what is conducted on the alternate current system of distribution—at all events in one light system I know of, in the Grosvenor Gallery installation that is the period of frequency, and I believe it is very much the same generally. Let us take this as an example—80 periods per second, take copper wire of 1 centimetre diameter, 2 centimetres diameter, and so on. Well, now in copper wire of 2 centimetres diameter the ohmic resistance is 8 per cent. more for the alternating current than for the steady current; in copper wire of 4 centimetres diameter the ohmic resistance is 63 per cent. more than for steady currents; in copper wire of 10 centimetres diameter the ohmic resistance is 4 times that it would be for steady currents. This is an interesting result; in copper wire of 100 centimetres diameter the ohmic resistance is seventeen times as great as it would be for steady currents. It is also interesting that from 10 centimetres diameter upwards, the ohmic conductance, that is, the reciprocal of the ohmic resistance, increases sensibly as the circumference simply, and not as the square of the diameter. The conductance for steady currents is as the square of the diameter all through; the conductance follows a law only expressible by these developments of Bessel's functions, until we get to a certain diameter; when we get to so great a diameter that the shell, so to speak—the outer portion of the wire into which the current is practically defined—is moderate or small in proportion to the diameter of the wire, then above that you can all see, without calculation, that the conductance is in simple proportion to the circumference. You may say practically that from 10 centimetres upwards the ohmic resistance is in simple proportion to the circumference with a deduction in the ratio of 79 to 70, the figure 79 corresponding to 10 centimetres diameter, 70 corresponding to an infinite diameter. This very imperfect explanation of the results may give some idea, but the complete table will show them for all sizes of copper wire from nothing to infinity. With a quadruple frequency the same figures apply to half diameter, there we get the telephone problem 80 × 4 = 320 that is among the frequencies for telephonic notes. Take the figures I have given, for instance, copper wire of 1 centimetre diameter for musical notes of 320 periods per second, the ohmic resistance is 8 per cent. greater than the resistance for steady currents: for a copper wire 2 centimetres diameter, frequency of musical note 320 per second, the ohmic resistance is 63 per cent. greater than the resistance for steady currents, and so on. Another important development from this theory is that there is much less importance in the conductivity of the metal for a telephonic wire than for ordinary electric work, when we try to attain to it by thick conductors such as I have been indicating. For example, take a copper wire of 2 centimetres, the figures are a little complicated, but I will only say that when circumstances are properly proportional, it is the square root of the resistance that we have to deal with instead of the simple resistance. Speaking roughly, the quadruple resistance is only twice as bad when the frequency is so great as to cause the effect of the ohmic resistance to be very much greater than the resistance for steady currents. The moral of this is not that you may choose wire of bad conductivity, on the contrary, take the best conductivity you can get, whether for telephones or for electric light conductors, but shape them so that the ohmic resistance shall not be too much augmented by the change of distribution of the current from uniformity which electromagnetic induction entails. The principles of working these are pretty well known to practical men, so that I do not think I need say much on the subject now. They have been known for a long time, but we are not much "forrader" in respect to the great question of electromagnetic theory. We have had a fine analogy from the time the known laws of electromagnetic induction were put into formulæ, in the beautiful manner in which Maxwell put them, with the motion of a viscous fluid, the equations for which were given originally by Professor Stokes. These considerations regarding the distribution of electric current in a conductor such as copper, and the distribution of motion of water in a viscous fluid, disturbed by periodic variations at the surface, follow identically the same law. Mr. Heaviside, referring to this, has well said that this analogy is very useful, because we can see the motions in a viscous fluid, and understand them and picture them to our minds, for it is more difficult to fancy we see the distribution of an electric current in a wire. Take this analogy. I am speaking of the distribution of electric current in a round copper wire, through which alternating currents of electricity are sent. Take a viscous fluid in a tube in place of the conducting wire, move the tube to and fro with a regular alternating motion, a simple harmonic motion. Imagine the tube I have here to be one of very great length, filled with viscous fluid, such as treacle or thick oil, and having pistons at its ends to fulfil the laws that I am speaking of, the length must be very great in comparison with the diameter, and the place where we look at and think of the fluid is very many diameters from the ends disturbed by the pistons. In the first place, if in such a tube, fitted with frictionless pistons, if the fluid were non-viscous, if it were perfectly liquid, the pistons might be moved, but the fluid would not move at all; water would move, but the more thick the fluid, the more liable is it to take motion in that way. There is a perfect analogy between the motion of the fluid, the alternating motion of the fluid transmitted inwards from the surface, and the distribution of electric current in a wire through which the effect of an alternate current machine is being conveyed. Another very interesting analogy, which has exactly the same law as the other, is change of temperature in a conducting solid due to variations of external temperature. We have got our tube of fluid; imagine there a column of rock, or stone, or metal, and instead of moving the tube to and fro longitudinally, let the atmosphere and surroundings of the stone column, or iron column, or metal column, be periodically varied in temperature, the law of penetration, of maximums, minimums and zeros midway between the maximum and minimum of temperature in the one case is identical with the corresponding law for electric current in the first-mentioned case, and of fluid motion in the other cases. In each case we have a propagation inwards with diminishing amplitude, in each case the rate of diminution of amplitude corresponds to the retardation of phase according to exactly the same law. I need not take up your time in giving the law, but you can easily understand it. Well now, we have a very perfect electromagnetic analogy for the simple case in the to and fro motion of a tube. Take another case; here the thermal analogy fails us—it absolutely fails us—it is absolutely inapplicable to what I am going to speak of now: the fluid motion analogy still holds: take a tube of fluid and give it a motion round its axis, that action will give a tangential drag if the motion be very quick, and will follow the same law for the to and fro motion of the cylinder and for the rotary motion of the cylinder. The question is this, does the variation penetrate to a large distance in from the outside or not? If it penetrates in to only one-hundredth of the radius, then it is obvious that we shall have the same law of penetration inwards for the disturbance, whether for the case of rotatory motion of the cylinder round its axis, or of longitudinal to and fro motion; exactly the same thing holds with electromagnetic induction. The one case that I mentioned first is the most important for telegraphic and telephonic current, but another of equal importance is that of a core within a solenoid through which an alternating current is being sent in opposite directions, producing magnetic lines of force parallel to the axis of the interior of the solenoid. Alternating magnetic forces induce electric currents in circles perpendicular to the direction of the forces; thus we have, as you all now know, currents induced in the solid metal core of a solenoid. A metallic core, such as iron, is a subject for investigation of an exceedingly easy character. The same Bessel's functions come in here just as they do in the other cases. But the inductive quality of iron, the different degrees of magnetisation according to circumstances, the increase and diminution of magnetisation or reversal of magnetisation, the great complications of inductive effects experienced with iron, introduce corresponding complications in the theory of the induced current, and other complications of a kind that present most formidable difficulties for mathematical analysis. The mathematical citadel of truth is there impregnable by any mathematical power that has yet been brought to attack that variation of magnetic susceptibility when the strength of the magnetic induction or magnetising force is taken into account. I am only going to say two or three words about an extension of that viscous fluid theory that allows us to take into account all that goes on both in air and in metal; I will confine myself to two very simple cases—parallel wires with alternate currents through them of the rotatory case, one cylinder rotated with a periodic motion of rotation alternately in opposite directions. The analogy I will state very shortly, it is simply this:—to represent different metals in the analogy, densities of fluid proportional to the electric conductivity must be taken, the viscosity must be the same in all. The representative of an insulator in this analogy is a massless fluid almost devoid of inertia; perhaps I ought to say an inertialess fluid, because people attach their ideas to mass sometimes rather than to inertia, but in strictest dynamic language mass is taken as inertia. The inertialess viscous fluid must take the place of air; a viscous fluid of a certain density, but the same degree of viscosity must take the place of lead; then, again, to take the place of copper a fluid of six times the density of lead, the conductivity of copper being, say, six times the conductivity of lead, a fluid of six times the density is the analogue of copper in the viscous analogy. I shall not pursue the subject farther, because to work it out with illustrations would run into more time than can well be afforded on such an occasion as this, but I would just call attention to the other case of rotation; exactly the same statements hold. I shall return to that presently, because I am going to speak of iron. When we come to iron there is no difficulty whatever in considering the one case or the other, but now one thing is hopeless, that is not hardly the word—we are never without hope in science—I was going to use another word, despair; I feel the probability of my seeing the solution of it, I may say, is hopeless—the electrostatic effect. To get the analogy of electrostatic effect, simply put in an interface between the two plates, and give it such stiffness against change of shape as to require it to fulfil the conditions which our knowledge of the laws of electromagnetic influence teaches us exist. Put in at the interface the requisite normal force and the solution can be extended to include the submarine telegraph problem, that is with electrostatic charge taken into account, the complete problem of a submarine cable where electro-magnetic and electrostatic induction are both taken into account, but it is only by putting in quite an arbitary manner a force at the surface to fulfil the requisite conditions that we can complete the analogy. The analogy I have just sketched cannot be considered as being in any respect a physical analogy, it is not molecular rotation of the fluid, the analogue to electric current is not velocity of the fluid, it is a quality derived from the simple motion of the fluid by the operation known as the Laplacian operation, the Laplacian of u, v, w is the electric current; another way of putting it is the rotation of u, v, w. The word "curl" was introduced by Clifford and Maxwell, and has, I grieve to see, been adopted by Mr. Oliver Heaviside. I object to the word. Curve is good, but curl is bad, and the method seems to be not desirable or instructive, and above all, not applicable to any practice of mathematics.

It is too difficult a subject to explain now, but I will just, by an illustration, try to illustrate it by a case. Take in the viscous fluid analogue what corresponds to the steady current in a wire. Here it is: think of a tube; at one end of the tube press a piston in with a uniform motion in the neighbourhood of the piston; the motion is disturbed by the rigidity of the piston, and to a distance of 10 or 20 millimetres from the piston the motion of the fluid takes a perfectly regular character. Suppose (diagram 1) that represents the inner surface of the tube; a portion of the fluid is sticking to the surface; there is absolutely no slip at the containing surface. I make it to exactly represent a parabola with its vertex in the tube, a vertex properly explained becomes a paraboloid of revolution; it is nothing *here* and is a maximum *here*. We have two functions derivable from the consideration of the depreciation of the velocity. The first is the rate of shearing of the fluid; the second is the rate of change per unit change of distance from the axis of the rate of shearing. First, then, the rate of shearing, then the rate of change of the rate of shearing. The rate of shearing is equal to the tangent of the inclination, the angle i, the tangent of the angle of this curve to the transverse surface. The rate of change of the rate of shearing from point to point is the analogue of viscous fluid force through a tube. In it we have not the average velocity equal to velocity of electric current, but something quite intelligible and very clear, but it is not the velocity of the fluid. Now, perhaps, there is this in this idea: I think we have a mathematical definition of electric current which is not fluid velocity. Well, now, perhaps, some will say had not we better get an analogy in which fluid velocity is equal to the velocity of electricity? I do not say whether we had better or not, but this analogy gives us a notion of the rotation of the magnetic force. Mr. Heaviside rather overlooks that merit in Maxwell's vector-potential; he objects to Maxwell's vector-potential. I do not like it, and heartily agree with him, because I think it is an unhappily chosen name. Maxwell puts down in his formulas as the foundation from which one step leads to magnetic forces and the next to electric current, something which, when translated, gives us a mean of which the rotation is the magnetic force, and it seems to me that if we are ever to have a real theory here it must be founded upon this view. The hand of the clock warns me that time is going on so rapidly that I must leave this analogy absolutely unfinished. Perhaps it is as well that we are obliged to leave it now, because the more we look at the result we like it if we wish to see a true mechanical explanation of electromagnetism; it is only a dream, an idea of a possibility that may ultimately lead to an explanation of magnetism. The work, the energy, is done in the wrong place; we find work done in the dielectric, this viscous, this massless fluid taking the place of the fluid. I must now leave it, but the reason that so much notice has been given to it to-night is that it is a perfect mathematical working analogy, and will be a useful and instructive kind of analogy, and a very potent aider in getting out and estimating out practical problems in respect to magneto-electric induction in dynamos, telephones, helices of electrical instruments, wire, and so on, in great variety of shape. But now there is another thought in connection with this subject, and that is the elastic solid thought. Will you allow me to read a very short statement, which was published in the *Cambridge and Mathematical Journal* for the year 1847; it is dated Glasgow University, November 28th, 1846, and it was written after I had been 28 days in my Professorship, and is as follows:—"Mr. Faraday, in his experimental researches in electricity, has set forth a theory of electrical induction which suggests the idea that there may be a problem in the theory of elastic solids corresponding to every problem connected with the depreciation of electricity, or with the forces of attraction and repulsion exercised by electrified bodies. . . . . I should exceed my present limits were I to enter into an examination of the state of a solid body representing the various problems of electricity and galvanism, which must therefore be reserved for a future paper." I can say that now as I said 42 years ago. I have been considering the subject for 42 years, night and day. I do not mean all of every night and all of every day, but there have been but very few days and nights on which I have not tried to find it out, but have not found it out yet. But we feel almost as if we are approaching towards it when we think of viscous fluid forced through a porous portion, a tubular portion filled with porous elastic matter. Let there be an elastic solid of exceedingly small density, and let there be a portion of it porous, but with the same aggregate rigidity, taking rigidity now instead of viscosity, somehow or other force a fluid through it, the pull of that fluid upon the porous solid will produce identically the same static rotations as we have of dynamic rotations, continued rotatory motion in the case of the viscous fluid; in fact, nothing but electricity and ether. The thing would be done. I would be perfectly satisfied if I were in the position of the juvenile electrician who thinks it is all electricity and ether, as if there was not another body of grave ponderable matter. I should be perfectly satisfied if it could be so, but I cannot deal with that now. As to magnetism, I said I would return to that, and I want just to call your attention to this. Imagine (diagram 2)  to be the section of an ordinary helix or solenoid, • representing the copper core through which an alternating current is passing; whatever the current of electricity may be, I believe it does pull the ether round. I do not think this is a dream of electro-magnetic theory; I believe it to be reliable. Astronomers do not cry out and make their lives miserable because they cannot explain the motion of the earth through this elastic solid ether; it is an absolute mystery, and people who deal with optics and astronomy are not expected to be miserable because they have that difficulty and mystery ever before them. Are we to be absolutely unhappy, then, because while we say it moves, we cannot by any possibility say how it does move; no greater mystery with reference to the laws of matter has ever been suggested or imagined. Somehow or other, however, the ether is pulled round, it has got a twisting motion like that in the interior of a solenoid. Somehow or other it does give motion to the copper, and somehow or other there is a motion following these very laws that we have been speaking of, and illustrating the viscous fluid analogy somehow or other in the copper. Now, instead of an alternating current through the helix, take a constant current. A constant current, what can it do but turn round the ether to a constant angle. Just one other thing is possible, it might keep dragging the ether round and round; either one thing or the other it does; either a constant current through this helix does drag the ether round and round inside it, or it drags it round to a certain angle proportional to the strength of the electric current; it does either the one or the other of these two things. Now how on earth can iron differ from copper. Our interfacial law depending on equal viscosities is very simple, but when you introduce iron, you introduce an interfacial difference without anything that could possibly be a cause of viscous action whatever, or a cause of electrostatic action; a cause of electrostatic action requires distortion; you have no elasticity of an elastic solid without distortion. Well now, all that you can do by applying a tangential force all round with a cylinder is to turn it; if you keep turning the circumference you will keep turning the contents, and if you turn the circumference to a certain angle and leave it, you will turn the contents to the same angle and leave it, and all the contents must be turned to the same angle. That is all we can get either from our viscous fluid analogy or the other analogies. The primary phenomena of the magnetisation in a bar of iron the core of a helix absolutely leaves it behind and cuts the ground from under us in our viscous fluid analogy and in our elastic solid analogy. If it is to be a fluid going round and round, we must have an action depending upon the fact that all goes round together; if we have no action round and round, but merely a certain drag of the ether round to a certain angle and then turning to equilibrium, we must have a force resisting steady rotation; we must at first sight have this debatable property of matter—here is a solid body, I apply a force to it, a definite torque, that is the effect of a couple of forces, tending to twist (it is now called a torque and not a couple): a certain torque tending to twist a body round, carries it round and round with accelerated motion. Well, now we must have an arrangement of matter in which a constant torque produces a constant angular displacement in a body and does not produce rotation. The only thing that can do that is an inherent rotation existing in the molecules of matter, that seems the only thing that can do it, and that can do it certainly, unless you introduce this other idea that an elastic solid may be moved in space, but even that must be movable ether. The gyrostat shows the thing, and I will conclude with a perfectly well-known experiment with the gyrostat that will illustrate the application of it with reference to the idea of a medium which has the properties of an imperceptible fluid and no rigidity except what is given to it gyrostatically. Here is a representation of a molecular skeleton that can give us such a fluid, consisting of a set of squares joined by flexible threads. Here is a square pattern of rigid squares, the corners are connected by endless threads; there are 16 squares, and I have nine rigid endless cord squares connected with corners in this pattern. If these be pulled out with equal force in all directions, we have a kind of web. Well now, in an ordinary cloth we can pull it in all directions—in the direction of the warp and in the direction of the woof, and you cannot stretch it; but cut a thing like a pocket-handkerchief at 45° to warp and woof, then you can stretch it, you all understand that; surgeons do that generally, I think, for their bandages. Suppose the cloth is un-



stretchable except in the diagonal direction; the same with these squares. If you alter a square into a rectangle the area remains sensibly unchanged; the first change of the area is a diminution in whatever direction you do it, but that is proportional to the square of the strain, so that you may say, mathematically, that the area is unchanged. The constancy of the periphery, then, of each of these figures entails the condition of an approximate constancy of the area. Here, then, we have the skeleton work of a medium which, looked at in two directions, is incompressible and inextensible, but is exchangeable in area, and is freely extensible in any opposite directions, provided you allow it to shrink in the perpendicular direction. Well, now, I say put a gyrostat into each of these squares, and you have all that is wanted to fulfil almost any conceivable condition that I put before you. (A gyrostat was set going, and some details of its action explained.) You can make it as immovable as you please by imagining the angular velocity of the flywheel to be great enough, and there is nothing to curb our imagination in this respect. (A gyroscope was shown, and its action described in detail as illustrating the same ideas.) I shall not detain you more than two or three minutes longer, just to show that we have a specially elastic solid in the structure. Do not imagine that a structure of this kind, gross as it is, is necessarily uninstructive; look at the structures of living things, look at the wonderful tactics in the structure of organic beings, think of what we have to explain in electricity and magnetism, and allow at least that there must be some kind of matter, we cannot suppose of dead matter to be without form and void and without any structure, there must be molecules of some shape, they must have some relation to one another, and surely we can imagine the thing exists, though we may be unable to perceive it. I do not admit that this is playing at theory, but it is helping our minds to think of possibilities, so that here is a structure that can be produced which is a perfect liquid, that is an incompressible frictionless liquid without any gyrostatic arrangement when no gyrostatic arrangement is given to it. Now, consider for a moment the effect of introducing gyrostats into each of these square: each of the squares becomes immovable, and you get a set of elastic threads stretched to the corners of immovable cubes, immovable in rotation, but perfectly free to take translatory motion. There you have a body, then, which you need not distinguish from an ordinary elastic solid so far as translation effect, so far as motion, as a whole, is concerned, but which if you try to turn it will not absolutely resist, but will only admit of turning by stretching of the connecting elastic bands, it will not be immovable in respect to turning, but it will be balanced by a constant couple with a constant degree of rotatory displacement. Thus, upon this solid the effect of a constant couple is not to produce continued rotation, but to produce a balance, a constant displacement of that balance might last for millions of years, if the rotational moment of momentum is but great enough. Lastly, I should just say briefly this, that the rotational quality of ether in iron must be enormously less than in copper or in air; the total rigidity due to elastic action and gyrostatic effect in all non-magnetic bodies is the same; the total rigidity of ether is the same in all non-magnetic bodies. In iron it is less, through less gyrostatic contribution with equal elastic contribution to the rigidity. Those conditions fulfil exactly what we want for the relations of ether between air and iron inside the helix of an electro-magnet. But now we are only landed in an absolutely immeasurable difficulty. We have a strange solid forced between the bodies connected with the system. Why is it that they do not balance themselves in the solid? How can there be a solid giving rise to these prodigious effects, such as when copper will fall down at the rate of a quarter ampère per second until it gets away free, and so on; how can it be that this prodigious effect is forced through a solid and yet other forces be perfectly free to move within that solid? I can only say that we have done all we can to think out this subject, but it merely gives us a dynamical theory of one part of it. The electrostatic part, our first love, has been left out in the cold, though I have spoken of it two or three times, but we do not touch it or get near it in any of this doctrine, and we do not get the mutual attraction between iron and copper, nor near the motion of the body that demonstrates this force, we only get the conclusions which mathematical theory lead us to believe exist. I must give up saying that the difficulties are so great by way of forming a comprehensive theory that we cannot imagine a single thing that leads us towards a conclusion. We cannot imagine it, but this time next year, or this time 10 or 100 years, it will probably be as easy to think we can understand that glass of water as to understand the solids that are now incomprehensible, the mysteries will be no mysteries at all, but the scales will fall from our eyes and we shall be able to look at things in a different way from now. I must ask you to pardon me for bringing it to such a conclusion, that we really know nothing about this grand subject which constitutes the province of the Institution of Electrical Engineers.



Votes of thanks were accorded to Mr. E. Graves for his presidency during the past year, and to Sir William Thomson for his address, and after a ballot for new members the proceedings terminated.

NEW PATENTS—1888.

18674. "Improvements in acoustic receivers for telephones." H. J. Sayer and A. E. Sayer. Dated December 21.

18677. "An electric switch." L. B. Bethell. Dated December 21.

18679. "A self-acting electric thermometer fire alarm, or temperature indicator, and atmospheric change indicator." L. B. Bethell. Dated December 21.

18712. "Improvements in electric locks, bolts, and the like." C. Wells. Dated December 21.

18715. "Improvements in or connected with telephones, speaking tubes, stethoscopes, phonographs, and other instruments through which sound waves pass." F. J. Smith. Dated December 21. (*Complete.*)

18718. "An improvement in tubular posts for telegraphic and other purposes." C. E. J. May. Dated December 21.

18727. "Improvements in electrical continuous current transformers." R. P. Sellon and C. Watson. Dated December 22.

18752. "Improvements in or connected with telethermometers." J. G. Lorrain. Dated December 22.

18754. "Improvements in or relating to galvanic batteries." G. C. Dymond. (Communicated by C. Gassner, Germany.) Dated December 22.

18763. "Improvements in apparatus for detecting the presence and direction of currents of electricity." C. B. Burdon. Dated December 22.

18784. "Method of and means for regulating electric currents, dynamo machines, and electric motors." W. F. Lahmeyer. Dated December 22.

18790. "Improved electrical signalling apparatus." S. Schuckert. Dated December 22.

18807. "Improvements in the method of and means for producing intermittent electric currents." T. Parker. Dated December 24.

18812. "Improved method and apparatus for the distribution of electricity by means of alternating currents of electricity in conjunction with electrical storage." R. F. Yorke. Dated December 24.

18825. "Improvements in switches for use in electric circuits." A. C. Cockburn. Dated December 24.

18832. "An electric miners' safety hand lamp which may be used for domestic and other purposes." E. T. Boston. Dated December 24.

18854. "Improvements in electrical switches." H. W. Short. Dated December 24.

18856. "Improvements in printing telegraphs." G. V. Sheffield and M. Lowenstein. Dated December 24.

18858. "Improvements in electro-chemical generators." F. J. Brougham. (Communicated by La Société Perreur-Lloyd & fils, France.) Dated December 24.

18881. "Improvements in the preparation of materials which have to be submitted either to voltaic heat or to electric heating, combined with electrolysis." L. Reuleaux. Dated December 27.

18900. "Improvements in electric telegraphy." M. W. Dewey. Dated December 27. (*Complete.*)

18908. "Improvements in electric arc lamps." G. B. Goodfellow and P. J. Charles. Dated December 27.

18911. "An improvement in dynamo-electric machines." B. H. Antill and E. F. H. H. Lauckert. Dated December 27.

18922. "Improvements in electrical switches." T. Wardell. Dated December 28.

18930. "An electric automatic work detector and recorder." J. Blamires and W. Blamires. Dated December 28.

18966. "Improvements in or connected with telegraphic transmitters." J. Timm. Dated December 28.

18978. "An oblique meshed grid plate for storage batteries." T. W. Bush. Dated December 29.

18981. "An inner expanded chamber grid plate for storage batteries." M. Doubleday. Dated December 29.

18991. "A bent plate storage battery." M. Doubleday and T. W. Bush. Dated December 29.

18994. "Improvements in and appertaining to the manufacture of metals, or metallic alloys by means of electricity." G. C. Dymond. (Communicated by J. M. A. G. Léscuyer, France.) Dated December 29.

19034. "Improvements in secondary voltaic batteries." W. J. S. Barber-Starkey. Dated December 31.

19043. "Improvements in and connected with insulating devices for supporting telegraph and other wires or electrical conductors." G. Fowler. Dated December 31.

19045. "Improvements in magnet call bells." T. J. Handford. (Communicated by The Western Electric Company, United States.) Dated December 31.

19047. "A new or improved method of refining sugar by electricity." R. W. Hewett. Dated December 31.

19049. "Improvements in electrical firing keys." F. V. Andersen. Dated December 31.

19058. "Improvements in electric batteries." J. Y. Johnson. (Communicated by F. Gendron, France.) Dated December 31.

19061. "An improvement in materials to be used in galvanic batteries." A. Cornwell. Dated December 31.

19070. "Improvement in electric arc lights." C. Wells. Dated December 31.

1889.

30. "Improvements relating to electric telegraphy." M. W. Dewey. Dated January 1.

46. "An improved atmospheric thermo-electric generator." W. S. de Lisle Roberts and J. S. Mollison. Dated January 1.

85. "Improvements in dynamo-electric machines." A. Poleschko. Dated January 2.

112. "A railway distant electric flashing signal." J. Woods and H. W. Hatfield. Dated January 3.

118. "Improvements in electric brakes for railway trains." W. P. Widdifield and A. H. Bowman. Dated January 3.

126. "An improvement in or relating to dynamos." G. B. Luckhoff. Dated January 3.

135. "Improvements in the arrangements for lighting and braking railway vehicles electrically." I. A. Timmis. Dated January 3.

179. "Improvement in the use of incandescent electric lights." C. Wells. Dated January 4.

189. "Improvements in armature winding for dynamo-electric machines." W. H. Knight. Dated January 4. [Dated applied for under Section 103 of the Patents', &c., Act, 1883, June 6th, 1888, being date of application in the United States.]

238. "Improvements in alternate current dynamo-electric machines." J. D. Gibbs and E. Fesquet. Dated January 5.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1888.

39. "An improvement in voltaic batteries." E. Tyer. Dated January 2. 8d. Claim:—Dividing the negative element of a voltaic battery into several parts or groups of parts, connected separately to a commutator, whereby any one of these parts or groups can be included in a circuit while the others remain in repose, substantially as and for the purpose set forth.

115. "Improvement in the insulation of electric appliances." S. W. Baynes. Dated January 4. 4d. Claims:—1. The enamelling of electric appliances or apparatus with a vitreous substance, so as to wake them insulated from the electric current. 2. The coating of the surface or surfaces of electric appliances or apparatus with a vitreous substance, so as to render them insulated, fire resisting, and moisture proof.

1016. "An improvement in electrical transforming apparatus." A. M. Taylor. Dated January 23. 4d. Relates to means of compensating for the effects produced in a system, where a constant electrical current is maintained in a primary circuit, and in which various inductors are arranged in series, when great changes are made in the number of lamps used, these lamps being arranged parallel in the secondary circuits of the inductors. Claim:—In combination with each of a number of inductors having their primary coils connected in series for passage of alternating electrical currents, and their secondary coils connected parallel to groups of lamps, an independent iron core wound with a coil of low resistance in shunt from the primary inductor coil, with or without separate convolutions connected to the secondary, substantially as and for the purpose set forth.

13035. "Improvements in the construction of socket electric lampholders, wall sockets, and electric lead connectors. C. M. Dorman and R. A. Smith. Dated September 10. 8d. Consists partly of an improved method of holding the contact springs to the porcelain or other insulator used by means of a single metallic stud to each spring, the same stud also serving as a terminal for the attachment of one of the leads; also of an improved method of securing the covering hood of a lampholder, wall-socket, or other similar connector without the use of screws, and in such a manner that it can easily be detached and replaced without the use of a screwdriver or other tool; and also of the general arrangement of the various parts and the method of holding the same together. The claims are 4 in number.

13123. "Improvements in the armatures of dynamo-electric machines." E. J. Paterson and C. F. Cooper. Dated September 11. 6d. Consists in casting in one piece with the driving axle the centre part of the armature which carries the soft iron core. This axle and centre the inventors cast of non-magnetic metal. If the soft iron core is built up of plates or washers they cast radial arms on the axle, the outside ends of which fit into slots or grooves cut in the interior of the washers. If the armature core is formed of iron wire they cast on the axle a hollow drum with flanges, on the exterior of which and between the flanges they wind the iron wire. There is 1 claim.

13192. "Improvements in or relating to bleaching by electrolysis." E. M. H. Andreoli. Dated September 12. 6d. Claim:—The bleaching of vegetable substances by means of anodes and cathodes of wood charcoal or vegetable or animal charcoal of any required form obtained as described, and also by means of electric arc carbons employed as anodes and cathodes in an electrolytic tank in conjunction with a chloride solution in the manner described.

14522. "Improvements in galvanic batteries." D. Humphreys. Dated October 9. 8d. Relates to galvanic batteries of that type in which the exciting liquid is agitated and aerated, and has for its object the production of an apparatus in which these objects will be more efficiently effected than heretofore, and in which accumulation of polarising gases on the negative electrode surface will be prevented. The present invention provides for the distribution of air over the entire negative surface of the battery elements and embodies apparatus for effecting these results; it also embodies apparatus for producing an agitation of the liquid by a mechanical agitator and conjoint aeration of the excitant; moreover it contemplates the use of such apparatus with simple battery solution or with solutions which contain depolarising materials. It also embodies devices in which air is carried into the excitant by a mechanical depolarising device alternately dipped into and withdrawn from the excitant. The claims are 10 in number.

CORRESPONDENCE.

The Ries Electric Railway—A Reply from Mr. Elias E. Ries.

In your issue of November 16th, 1888, you criticise several features of the Ries electric railway system, more especially those relating to the combined or alternative use, under certain conditions, of the secondary battery and line conductor methods of supply.

Permit me to say that you have evidently fallen into the error of basing what by some might be taken as an expert opinion, upon the strength of a circular intended chiefly for the information of non-technical readers, and which you yourself admit does not contain sufficient description to enable you to judge as to the merit of the system described. The criticisms you thus prematurely make with regard to the operativeness and practical value of the various "systems or parts of systems," are not only entirely unwarranted by the facts of the case, but there is to my mind nothing in the circular from which you quote that can justify, except perhaps by inference or comparison with preexisting methods, such conclusions as are reached by you.

As an example, in referring to the combined line conductor and secondary battery method of operation, in which the cars are provided with from one to two hour's supply of propelling current to be used on branch or suburban extensions, and in case of emergency upon the main line you "wonder how the '*few cells of secondary battery*,' in each car are connected up to operate a motor that is wound for a line current at 300 volts." If you will kindly refer to copies of my U. S. patents, Nos. 390,904, 390,905, and 390,906, granted October 9th, 1888, the manner in which this is accomplished will be apparent. You will find that in cases where the combined system is employed the motor is provided with a "multiple" armature winding and a commutator divided into as many separate sections as there are windings. By means of a simple switch these windings can be grouped or connected together in series, in parallel, or part in series and part in parallel, as desired, while the motor is running. This arrangement permits of instantly changing the resistance of the armature, or, in other words, the length and sectional area of the conductors composing its coils, in such a manner as to enable the motor to operate equally well under different electromotive forces, and, I may state in passing, is productive of numerous other important results not met with in any other electric railway system.

When the motor is receiving current from the line, the several conductors of the multiple winding are connected in series. We will assume that under these conditions, with a given load, the motor is taking a current of 20 ampères at the 300 volts difference of potential maintained between the line conductors. Now, whenever it should be found necessary or desirable to substitute the battery for the line current, a single movement of the switch will cut out the line, connect part or all of the multiple armature windings in parallel and establish connection with the battery, so that under substantially similar conditions of load and speed the motor will take a current of 100 ampères at 60 volts from the 32 cells of secondary battery carried. In practice the motor windings are so arranged upon this principle (see patents above referred to) that the machine will act as a *motor generator* for the purpose of recharging the secondary battery whenever the motor is doing less than its normal amount of work in traction. For this purpose the armature is preferably provided with two separate windings, one or both of which are divisible. Both windings may be connected to the same circuit or operated independently, and the resistance of one or both may be independently varied. Any desired portion of the total armature winding may be receiving current from the line while the remainder is generating a current for recharging the battery at a different electromotive force. In starting or ascending exceptionally steep grades both the line and battery currents may be drawn upon, the effect of both currents upon the motor being cumulative, or the two windings may be operated directly from the line in multiple. The divisibility of the armature winding also permits of starting the motor with the separate conductors of the winding in series, and of gradually reducing the armature resistance as the counter electromotive force developed is increased. In short, it will be apparent from what has just been said that it is not only quite practicable to employ both the line and the auxiliary battery in the manner indicated, but also that this system possesses not merely a very high degree of flexibility, but numerous practical and economical advantages that are entirely absent in the individual line conductor and battery systems, and which for many tramway lines will render this the ideal method of operation. The motor employed with the combined system is by preference separately excited, and notwithstanding its peculiar organisation is in every respect a most simple and economical machine, capable of operating at its maximum efficiency in either capacity.

Under the head of "The Return of Power on Descending Grades," in which a different application of the secondary battery and line principle is made, you claim to find "an old idea rejuvenated and attached to the system under discussion," this idea being attributed by you to the late Sir William Siemens. It is due to me to state that I have not been aware that Sir William or any one else ever proposed to utilise the surplus energy of an electric railway car for the purpose of recharging a secondary battery prior to my own invention thereof. The allegation that this feature is "an old idea rejuvenated" is, therefore, hardly warranted by the circumstances in the present case. However, the conditions met with in operating a line of railway on this plan are such that no mere "idea" of the kind referred to by you would be likely to prove sufficient for practical operation, and the fact that the suggestion made so long ago has not been acted upon, together with the sceptical manner in which you introduce the present method to the notice of your readers, would seem to indicate that several important features essential to success were missing in the original plan, which it is believed cannot be said of the method under discussion.

After reproducing a portion of the description bearing upon this method of conserving the surplus energy of the motor-car on descending grades, "In the hope of amusing your readers," you continue :—"Does Mr. Ries not know that the motor, when working as a generator, has to run faster than under normal conditions, in order to overcome the counter E.M.F. of the battery, and that it ceases to generate the moment its speed is reduced by but a few per cent.? Instead of utilising as a brake power the momentum of the car for charging the cells, he will find that the same will be *discharged* at a high rate. We only hope Mr. Ries will reconsider the subject before applying this combination in the manner indicated."

I cannot understand what grounds you have upon which to base these remarks, and am free to say that had they been made by any electrical journal less influential and favourably known than the ELECTRICAL REVIEW, I should have passed them by as being entirely too frivolous and trifling in their character to warrant a reply. It is safe to say that your rather elementary query, while it may, perhaps, have been profitably directed to some of the previous attempts in this direction to which you refer, would not have been asked had you been aware of even the essential details or characteristics of the present method.

If you will refer to your issue of the week previous to the appearance of your criticism, in which you publish some remarks made by me upon this subject at a recent meeting of the American Institute of Electrical Engineers (see page 525, issue of November 9th, 1888), you will find it distinctly stated, as a fundamental principle of this method, and one upon which its economy and consequent value directly depends, that by the use of a secondary battery in the manner there described, the counter or battery E.M.F. is always considerably less than the direct E.M.F. of the generating motor, and this relation continues until the speed of the armature has been reduced to only a comparatively few turns per minute, or until the direct E.M.F. has fallen from 300 to, say, 60, or even 30 volts or less. An automatic "potential switch," of special construction, is provided for establishing and interrupting the connection between the motor and battery at the proper times. I am not at liberty, nor have I the time at present, to discuss fully the nature of the extremely simple means employed to render this particular system entirely automatic, reliable, and economical in its operation. So far as the question of counter E.M.F. raised by you is concerned, however, I may state that while I prefer to employ the method referred to on page 525, which consists in grouping the battery sections in parallel when about to receive a charge (it has been found that cells so connected will charge uniformly, notwithstanding recent statements to the contrary), and connecting them in series when required for operating the motor,[*] it must be remembered that in some cases a similar, though, perhaps, a less satisfactory result, can be attained without any change in the battery connections, by increasing the field magnet strength as the speed of the armature decreases. Either or both of these methods may be employed, according to the requirements of the particular road upon which the system is to be applied, and both will avoid the difficulty to which you allude.

In conclusion, it should be stated that the Ries electric railway system is not, as one might be led to suppose from your description, an aggregation of well-known devices of uncertain merit; but the various inventions and patents upon which it is based embody some of the most novel, important, and essential methods and appliances relating to electric railways that have been so far devised, and the system is now capable of independently and satisfactorily meeting every practical requirement and emergency. Comparatively few details of this system have as yet been made public, nor will they be until this can be done with safety, from a legal standpoint; but it is safe to say that when they are you will not find it necessary to repeat the gratuitous but superfluous advice you so very considerately (?) extend, when you remark that: "We only hope Mr. Ries will reconsider the subject before applying this combination in the manner indicated!"

---

[*] The connections here described are employed when this method is applied to secondary battery cars, or to cars having motors of the ordinary type. In the case of motors provided with the divisible armature winding previously referred to, a much smaller battery is used, the cells of which are permanently in series with one another. In this case the whole or any desired part of the motor winding may be utilised as the generating medium on down grades. E. E. R.

Elias E. Ries.

Baltimore, Md., U.S.A.,
December 31st, 1888.

[We shall probably have something to say on this matter in our next issue.—EDS. ELEC. REV.]

Lighting by Vacuum Tubes.

We enclose a photo which may be of sufficient interest to the majority of your readers to repay the expenditure necessary to engrave it.

It is of a statuary recess illuminated by vacuum tubes, the light of the tubes being the only illumination. The tubes were run from one of our patent breaks and coils, the lighting in this instance lasting over five hours. We believe that this is the first instance of illumination by this means, which was only rendered practical by our continuous working break, the description of which will be duly published as soon as the patent appears. Photographic readers will be interested to know that the exposure was 10 minutes.

Pyke & Barnett.

January 12th, 1889.

[We do not think it necessary to illustrate this letter, and our correspondents are mistaken in supposing theirs to be the first attempt at illuminating by the method stated.—EDS. ELEC. REV.]

The Safety of Electric Lighting Installations.

In the last issue of your journal, you published an admirable set of "Regulations for the Safety of Electrical Installations," issued by the Electrotechnical Association of Vienna.

It is to be noticed that the association consider an alternating potential of 150 volts to be as dangerous as a continuous one of 300 volts. I can certainly bear out their view, having had some time back an experience of alternating continuously between two installations of the above class, where both circuits were leaky. The personal quantity of discomfort in attending to lamps, &c., *tace* Mr. Addenbrooke, was equally great in both cases.

Under "Conductors," paragraph 4, a clerical error has crept in, "3 ampères per square centimetre, &c.," should read "3 ampères per square millimetre, &c."

The Viennese association evidently had a definite limit of safety, some 2,000 ampères per square inch. How different all this is to Rule No. 2, issued by the Phœnix Fire Office, where the deliciously vague statement is made that the area of a conductor must be sufficient to carry at least 100 per cent. more electricity (current is meant, presumably) through it, than ever can be required for the lights they supply.

It would appear that the sets of rules were drawn up under conditions totally dissimilar. The Viennese rules are intended to be read and understood by everyone; in the Phœnix rules, on the other hand, the inspector equation is paramount; this kind of equation is not easy to solve, except in the fashion of Alexander.

Why, in the foreign rules, bringing conductors up chases in the wall should be objected to it is rather difficult to discover a reason for. Resin for soldering is also tabooed.

Rule 42 says: "At points where a contact with telegraph or telephone wires is possible, self-acting cut-outs must be introduced before and behind the dangerous places." This protects their own line, but not the telephone line, which ought to be guarded, if it was erected prior to the light conductors. The consideration that the two sets of rules would be advantageously compare by some of your readers, has alone induced me t forward these few lines.

A. R. H.

Lead-Covered Cables.

It is interesting to note in your issue of December 28th that you electricians are compelled to use an to condemn an article which we plumbers think ha not up to the present time been equalled. In you article on lead-covered cables I find you have more t say about the lead than what is contained within th metal casing; you will therefore excuse a plumber fo criticising a few points in your interesting article, fo you show that all at once the metal lead has become a complete failure, for durability, unless it has othe metals mixed with it. Now, I may say you have no gone far into the mysteries of lead, and the working o it, for if you had you would have formed quite a differen opinion from that which you have expressed—that pur lead is not durable. You have a good deal to say about the ancients, but the most important point is omitted, for although they used lead as pure as they could obtain it, it of course contained various other metals. But other things must be considered; the ancients knew nothing of drawn lead; they always cast it into what shape they required it, and this, be it remembered, was from ¼ inch to ½ inch thick, and it is acknowledged up to the present time that cast lead is more durable than drawn lead, although it is not so perfect, for it is difficult to cast it free from holes. With the lead of to-day we plumbers (whose trade, I might say, is one of the oldest in existence) say give us pure lead, and especially when bending or other work has to be done upon it. If on working a piece of lead it breaks, the plumber says "This is impure," and discontinues using it. Farther, if pure lead is so bad why do all the water companies compel *lead*, and no other composition, to be used? Surely these bodies, which have had more experience with lead (and other metals) than the electrician, ought to be taken note of, for they have found lead to be the best from every-day experience; and this experience is rather extensive, considering that every house has a lead water pipe running into it from the main in the road through all sorts of earth, subways, and every condition under which it is possible to find the true value of durability in practical work. And, from observations, the life of pure lead, or as it has been used for the last 100 years, will last under ordinary circumstances (not in a white lead mill or in creosoted wood) from 50 to 100 years, by far too long for the plumbers. I can only assume that you have based your article on the fact that pure lead is carbonated more readily than impure lead (or compo, as we call it), and even this, unless it has a large proportion of tin in its composition, is carbonated (see ELECTRICAL REVIEW, December 14th, 1888, page 659). I, as a plumber, have known this fact for years, for it is like using lead pipe in a white lead works, and surely it is not necessary to use creosoted wood in connections, for it is like using lead for the fire bars of a stove. But because pure lead will not answer under this creosoted case is it to be condemned?

With regard to impure lead I mentioned the fact of its breaking if worked; it can be tested with a stick of solder (tin and lead) and a stick of lead. Bend them backwards and forwards until one breaks, and this will be the solder. Again, make a cut with a knife in each, and again repeat this bending, and you will find the solder break short off. Now for the durability of this tin and lead (solder). I have found from observation that in all soldered joints on pure lead the decay is about three or four times greater than in the lead; for instance, a lead cistern always gives way at the solder joint. This proves which is the better metal of the two for durability. Again, all best work is soldered with pure lead (burnt), but this being expensive work it is not often done.

J. J. Rawlings, R.P.

[redacted]